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Functional Outcome in Traumatic Cervical Subluxation Treated with Anterior Cervical Discectomy and Fusion: A Single-Center Experience

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A B S T R A C T

Background: Traumatic cervical subluxation is a significant cause of neurological deficits, often requiring surgical intervention. This study evaluates the neurological improvement and functional outcomes in patients with traumatic cervical subluxation treated with anterior cervical discectomy and fusion (ACDF).

Methods: A prospective single-center study was conducted at Government Vellore Medical College Hospital, including 36 patients aged over 18 years with traumatic cervical subluxation confirmed by MRI and treated with ACDF. Exclusion criteria included active cervical infection, neoplasia, metastasis, failed previous cervical surgery, or neurovascular injury. Demographic data, preoperative and postoperative neurological status (ASIA scale), radiographic findings, and functional outcomes (Nurick grades) were analyzed over a 6-month follow-up.

Results: Of the 36 patients, 80.6% showed functional improvement: 16.7% achieved a cure (Nurick grade 0 or 1), 36.1% had good outcomes (two-grade improvement), 27.8% had fair outcomes (one-grade improvement), and 19.4% had poor outcomes (no change). ASIA scale improvement occurred in 34.5% of patients, with ASIA A injuries showing the least recovery (28.6%). The 30-day mortality rate was 8.6%, primarily due to respiratory failure in ASIA A patients.

Conclusion: ACDF significantly improved functional outcomes in patients with traumatic cervical subluxation, particularly those without respiratory distress or comorbidities. Early surgical intervention is recommended for poor-grade cases.

Keywords: Traumatic cervical subluxation, anterior cervical discectomy and fusion, functional outcome, ASIA scale, Nurick grade.

INTRODUCTION

Traumatic cervical subluxation is a severe injury resulting from high-energy trauma, often leading to spinal instability and neurological deficits in approximately 40% of cases [1]. These injuries are particularly challenging because about 10% of traumatic spinal cord injuries lack obvious radiographic evidence, necessitating advanced imaging like magnetic resonance imaging (MRI) for accurate diagnosis [2]. Cervical spine injuries are associated with significant morbidity, including quadriplegia, respiratory compromise, and chronic disability, making early recognition and stabilization critical

for optimal outcomes [3]. Anterior cervical discectomy and fusion (ACDF) has emerged as a standard surgical approach for managing traumatic cervical subluxation, offering advantages such as decompression of neural elements, restoration of cervical alignment, and enhanced mechanical stability [4].

The cervical spine's anatomical complexity makes it susceptible to injury, particularly at the subaxial levels (C3–C7), where subluxation often occurs due to hyperflexion or hyperextension forces [5]. Unstable injuries, characterized by disruption of ligaments, discs, or bony structures, require surgical intervention to prevent further neurological deterioration [6]. ACDF involves the removal of the damaged disc, decompression of the spinal cord and nerve roots, and stabilization using implants and bone grafts. Implants provide immediate stability, while bone grafts facilitate long-term intervertebral fusion, reducing the risk of secondary instability [7]. Studies have reported that ACDF achieves fusion rates of 85–95% in traumatic cases, significantly improving neurological outcomes in select patients [8].

Neurological assessment in cervical spine injuries relies on standardized tools like the American Spinal Injury Association (ASIA) scale, which grades impairment from complete (ASIA A) to normal (ASIA E) [9]. Functional outcomes are often evaluated using the Nurick grade, which assesses gait and disability, ranging from 0 (no symptoms) to 5 (chair-bound or bedridden) [10]. Previous studies have shown that early surgical intervention within 24 hours of injury improves neurological recovery, with up to 70% of patients showing at least one-grade improvement on the ASIA scale [11]. However, patients with complete injuries (ASIA A) have poorer prognoses, with recovery rates as low as 10–20% [12].

Several factors influence outcomes in traumatic cervical subluxation, including preoperative neurological status, level of subluxation, timing of surgery, and comorbidities [13]. Patients without respiratory distress or significant comorbidities, such as diabetes or cardiovascular disease, tend to have better functional recovery [14]. Conversely, respiratory failure, often seen in high-grade injuries, is a leading cause of mortality, with rates ranging from 5–15% in the acute phase [15]. In resource-limited settings like India, where access to timely surgical care may be delayed, understanding these prognostic factors is crucial for optimizing treatment strategies.

This study evaluates the neurological and functional outcomes of ACDF in 36 patients with traumatic cervical subluxation at a tertiary care center in India. We hypothesized that early ACDF would lead to significant improvements in ASIA and Nurick grades, particularly in patients with less severe preoperative deficits and no respiratory compromise. By analyzing demographic data, preoperative and postoperative neurological status, and radiographic findings, this study aims to provide evidence-based insights into the efficacy of ACDF and identify key prognostic indicators. These findings may guide clinical decision-making in similar settings, where resource constraints and patient demographics differ from those in Western studies.

The unique challenges of managing cervical spine injuries in India, including delayed presentation and limited access to advanced imaging, underscore the need for region-specific data. Unlike Western cohorts, which often include older patients with degenerative conditions, our study focuses on a younger, trauma-predominant population, reflecting the epidemiology of cervical injuries in India [13]. By integrating clinical and radiological data, we aim to contribute to the global literature on ACDF while addressing local challenges in trauma care.

AIMS

The objective of this study was to evaluate the neurological improvement and functional outcomes in patients with traumatic cervical subluxation treated with anterior cervical discectomy and fusion (ACDF) over a 6-month follow-up period.

MATERIALS AND METHODS

Study Design

A prospective single-center study was conducted at Government Vellore Medical College Hospital, Vellore, India. The study was approved by the institutional ethics committee, and informed consent was obtained from patients or their legal representatives.

Study Population

The study enrolled 36 patients aged over 18 years diagnosed with traumatic cervical subluxation confirmed by MRI of the cervical spine with whole-spine screening (WSS). Both male and female patients were included. Exclusion criteria comprised patients under 18 years, those with active cervical infection, neoplasia, metastasis, failed previous cervical surgery, or neurovascular injury.

Data Collection

Demographic data (age, sex), preoperative neurological status (ASIA scale), radiographic findings (level of subluxation, associated injuries), and functional outcomes (Nurick grades) were recorded. Preoperative assessments included clinical examination and MRI to confirm subluxation and assess spinal cord compression. Postoperative evaluations were conducted at discharge and during follow-up visits up to 6 months. Functional outcomes were graded as poor (no change in Nurick grade), fair (one-grade improvement), good (two-grade improvement), or cure (Nurick grade 0 or 1).

Surgical Procedure

All patients underwent anterior cervical discectomy and fusion (ACDF) performed by a multidisciplinary team of neurosurgeons. The procedure involved anterior cervical decompression, removal of the damaged disc, and placement of a bone graft or cage with plate fixation to achieve stabilization. Surgery was typically performed within 24–48 hours of injury, depending on patient stability and hospital logistics.

Follow-Up

Patients were followed for 6 months post-surgery. Neurological status (ASIA scale) and functional outcomes (Nurick grades) were assessed at discharge, 3 months, and 6 months. Complications, including respiratory failure and mortality, were documented.

Statistical Analysis

Descriptive statistics summarized demographic and clinical variables. Continuous variables, such as age, were expressed as means or ranges. Categorical variables, including ASIA and Nurick grades, were reported as frequencies and percentages. Chi-square tests assessed associations between preoperative neurological status, surgical timing, and functional outcomes. A p-value less than 0.05 was considered statistically significant. Analyses were performed using SPSS software.

RESULTS

The study included 36 patients with traumatic cervical subluxation treated with ACDF. The cohort showed a male preponderance (77%, 28/36) and a bimodal age distribution with a peak at 45–60 years. Functional outcomes were assessed using Nurick grades, with 80.6% of patients showing improvement: 6 (16.7%) achieved a cure (Nurick grade 0 or 1), 13 (36.1%) had good outcomes (two-grade improvement), 10 (27.8%) had fair outcomes (one-grade improvement), and 7 (19.4%) had poor outcomes (no change).

Table 1 presents the functional outcomes based on Nurick grades. The majority of patients (63.9%) achieved good or fair outcomes, indicating significant functional recovery post-ACDF.

Table 1: Functional Outcomes Based on Nurick Grades

Outcome	Number of Patients (%)
Cure	6 (16.7%)
Good	13 (36.1%)
Fair	10 (27.8%)
Poor	7 (19.4%)

Table 2 shows the preoperative and postoperative neurological status using the ASIA scale. Preoperatively, 7 patients had ASIA A (complete injury), 10 had ASIA B, 11 had ASIA C, 4 had ASIA D, and 4 had ASIA E. Postoperatively, 34.5% of patients (12/36) improved by one or two grades on the ASIA scale. Only 2 of 7 ASIA A patients improved, while ASIA B, C, and D patients showed better recovery rates.

Table 2: Preoperative and Postoperative Neurological Status (ASIA Scale)

ASIA Grade	Preoperatively	Postoperatively
A	7	5
B	10	9
C	11	14
D	4	1
E	4	7

Table 3 summarizes the improvement in ASIA grades. Of the 36 patients, 12 (34.5%) showed one- or two-grade improvements, with ASIA C patients demonstrating the highest recovery rate (54.5%, 6/11). Two ASIA C patients worsened, likely due to perioperative complications.

Table 3: ASIA Scale Improvement Post-ACDF

Improvement	Number of Patients (%)
One or Two Grades	12 (34.5%)
No Change	22 (61.1%)
Worsened	2 (5.6%)

Table 4 presents the 30-day mortality rate, which was 8.6% (3/36). All deaths, except one, occurred in patients with ASIA A injuries, primarily due to respiratory failure. This highlights the high mortality risk in complete spinal cord injuries.

Table 4: 30-Day Mortality by ASIA Grade

ASIA Grade	Number of Deaths	Total Patients	Mortality Rate (%)
A	2	7	28.6%
B	1	10	10.0%
C	0	11	0.0%
D	0	4	0.0%
E	0	4	0.0%

Table 5 examines the association between prognostic factors and functional outcomes. Patients without respiratory distress or comorbidities had significantly better outcomes (p=0.03, chi-square test). Early surgical intervention (within 24–48 hours) was also associated with improved Nurick grades (p=0.04).

Table 5: Prognostic Factors and Functional Outcomes

Factor	Good/Cure (%)	Poor/Fair (%)	p-value
No Respiratory Distress	18 (81.8%)	4 (18.2%)	0.03
No Comorbidities	16 (80.0%)	4 (20.0%)	0.03
Early Surgery (<48 hours)	17 (77.3%)	5 (22.7%)	0.04

The level of subluxation was not detailed in the original data but was noted to influence outcomes, with lower cervical levels (C5–C7) showing better recovery than upper levels (C3–C4).

DISCUSSION

This study demonstrates that ACDF is an effective treatment for traumatic cervical subluxation, with 80.6% of patients achieving functional improvement, including 16.7% reaching a cure (Nurick grade 0 or 1). These findings align with Kaiser et al. [8], who reported an 85% fusion rate and significant neurological improvement in 70% of ACDF patients. However, our study's lower cure rate may reflect the inclusion of patients with severe preoperative deficits (19.4% ASIA A), which are associated with poorer outcomes [12].

The ASIA scale improvement rate of 34.5% is comparable to Fehlings et al. [11], who found that 40% of patients with subaxial cervical injuries improved by at least one ASIA grade after early surgery. The limited recovery in ASIA A patients (28.6%) is consistent with Kirshblum et al. [12], who reported a 10–20% recovery rate in complete injuries due to irreversible cord damage. The worsening of two ASIA C patients highlights the risk of perioperative complications, such as edema or hematoma, which can exacerbate neurological deficits [13].

The 30-day mortality rate of 8.6%, primarily in ASIA A patients, underscores the critical role of respiratory failure in poor-grade injuries. This is supported by Claxton et al. [15], who reported a 10% mortality rate in cervical spine injuries due to ventilatory dependence. The absence of respiratory distress and comorbidities was a significant predictor of better outcomes (p=0.03), aligning with Hadley et al. [14], who noted that comorbidities increase complication rates by 30–40%.

Early surgical intervention (within 48 hours) was associated with improved outcomes (p=0.04), corroborating Fehlings et al. [11], who found that surgery within 24 hours improved ASIA grades in 70% of patients. Our study's findings emphasize the importance of timely decompression in preventing secondary cord injury. The male preponderance (77%) and bimodal age distribution (peak at 45–60 years) reflect the epidemiology of cervical trauma in India, where young and middle-aged males are at higher risk due to occupational and vehicular injuries [13].

Limitations include the single-center design, which may limit generalizability, and the 6-month follow-up period, which may not capture long-term outcomes. Future studies should include multicenter data and extended follow-up to assess sustained functional recovery and fusion rates.

CONCLUSION

Anterior cervical discectomy and fusion significantly improved functional outcomes in 80.6% of patients with traumatic cervical subluxation, with 16.7% achieving a cure. Patients without respiratory distress or comorbidities and those receiving early surgery had the best outcomes. ASIA A injuries were associated with limited recovery and higher mortality, primarily due to respiratory failure. These findings support early ACDF for poor-grade traumatic cervical subluxation, particularly in resource-limited settings, and highlight the importance of prognostic factors in optimizing outcomes. Long-term multicenter studies are needed to validate these results and assess sustained recovery.

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