



Epidemiology and treatment of central cord syndrome in the United States

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Background: The objective of this study is to demonstrate the epidemiology and trends in management of patients with central cord syndrome (CCS) who present to the emergency department. Recent literature has reported that surgical treatment for CCS have increased over the previous decades.

Methods: The National Emergency Department Sample (NEDS) was queried from 2009 through 2012 to generate national estimates of patients who presented to the emergency department in the United States and were diagnosed with CCS.

Results: From 2009 through 2012, there were 11,975 emergency room visits for CCS (mean age 60 years). The two most common injury mechanisms were: fall (55%) and motor vehicle accident (15%). Concomitant cervical fractures were found in 10% patients. Ninety-three percent of patients were admitted to the hospital directly or after transfer to another facility, and 7% were discharged home. Fifty-five percent of patients were treated non-operatively, 39% were treated with cervical fusion surgery and 6% were treated with laminoplasty. Of patients who underwent cervical fusion, 62% received anterior decompression and fusion, 32% received posterior decompression and fusion, and 6% received combined anterior-posterior decompression and fusion. The incidence of in-hospital mortality was 2.6%. Mortality was associated with older patient age (OR 1.06, P<0.001) and greater comorbidities (OR 1.72, P<0.001).

Conclusions: Majority of patients who presented to the emergency room for CCS in the United States were treated non-operatively. Advanced age and greater comorbidities were the factors that were most associated with increased risk of in-hospital mortality in patients with CCS.

Keywords: Central cord syndrome; epidemiology; spinal cord injury

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Introduction

Acute central cord syndrome (CCS) is the most common incomplete spinal cord injury in the United States (1-3). The clinical presentation was initially described in 1954 as motor deficits, more predominant in the upper than lower extremities with variable sensory, bowel and bladder symptoms (4). Since then, several studies have demonstrated variability in the presentation of this incomplete spinal

cord injury (5-7). Acute CCS typically results from a hyperextension mechanism and is commonly seen in elderly patients with pre-existing cervical spondylosis (4,7). However, a bimodal distribution has been described and highlights that CCS is not limited to a single patient demographic but occurs on a spectrum which includes young patients sustaining high energy trauma (3).

Treatment of acute CCS is controversial (2,8,9). Historically, non-operative treatment was supported by the

literature (4). There was a shift toward surgical management in the late 1990's as surgical techniques improved and favorable outcomes were reported (10,11). Since then, attention has shifted to determining the optimal timing of surgery and the preferred surgical approach (12,13).

The variability in clinical manifestation, underlying spinal pathology, associated cervical spine fractures and coexisting medical co-morbidities makes standardizing treatment of CCS difficult. Practice patterns have evolved as surgical techniques have advanced, and recent literature has demonstrated that the treatment paradigm for CCS has shifted increasingly toward surgery (1,14). The goal of our current study was to demonstrate the epidemiology and trends in management of patients with CCS who present to the emergency room. Specifically, our aim was to analyze patient and injury characteristics, emergency room and hospital characteristics, treatment practices, and in-hospital mortality associated with management of CCS.

Methods

The study utilized publicly available de-identified data and was exempt from the Institutional Review Board.

Data source

The National Emergency Department Sample (NEDS) maintained by the United States Agency for Healthcare Research and Quality is a composite sample of the State Inpatient Databases (SID) and State Emergency Department Databases (SEDD). NEDS can be queried by diagnostic and procedural International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes and can be used to create national estimates of patients initially seen in the emergency room and then admitted to the hospital.

For our study, the NEDS database was queried from 2009 through 2012 to identify all patients in the United States who were ≥ 18 years of age and presented to the emergency room and were diagnosed with CCS (ICD-9-CM codes: 952.03 and 952.08). Linkage variables were used to query the associated in-patient hospital stay and any associated surgeries during the hospitalization.

Data analysis

The database was queried for the following variables:

patient and injury characteristics (patient age, gender, injury mechanism, associated cervical fractures, and overall injury severity score), emergency room and hospital characteristics (trauma center designation, emergency room disposition, hospital teaching status), treatment practices (non-operative *vs.* surgical, type of surgery), length of stay and post-hospitalization disposition, and in-hospital mortality. Significance was set at $P < 0.01$ for all analyses.

Results

Patient demographics

From 2009 through 2012, there were 11,975 emergency room visits for CCS. The mean age at presentation was 60.0 ± 15.2 years. A proportion of 74.3% patients were male, and 25.7% patients were female.

Injury mechanism

The mean injury severity score was 17.5 ± 4.0 , and 66% patients were noted to have multiple injuries. Injury mechanisms were listed as: fall in 55% patients, motor vehicle accident in 15% patients, pedestrian struck in 4% patients, assault in 2% patients, and miscellaneous/other in 24% patients. Overall, 10% patients with CCS were noted to have cervical fractures concomitantly.

Emergency room characteristics

A total of 80.5% patients presented to a trauma center for initial evaluation. Of the patients who presented to a trauma center, 48% were at a Level 1 center, 21% were at a Level 2 center, and 5% were at a Level 3 center. The remaining 26% patients who presented to a trauma center were missing trauma center level designation data.

Hospital characteristics

Overall, 89% patients were directly admitted to the hospital from the emergency room, 4% patients were transferred to another facility for further treatment and remaining 7% were discharged home from the hospital. The rate of transfer to another facility was significantly higher among the non-trauma center emergency facilities compared to trauma centers (12% *vs.* 2%, $P < 0.001$). Overall, 66.5% hospitals were teaching facilities, and

33.5% were non-teaching facilities.

Treatment practices

Of all patients with CCS who were admitted to the hospital, 55% were treated non-operatively, 39% underwent cervical fusion, and 6% underwent laminoplasty. Of the patients who underwent cervical fusion surgery, 62% received anterior cervical decompression and fusion, 32% underwent posterior-only decompression and fusion, and 6% received combined anterior-posterior decompression and fusion.

There was no significant difference between the 3 fusion groups by comorbidities ($P=0.506$), injury severity score ($P=0.646$), or injury mechanism ($P=0.269$). The rate of combined anterior-posterior decompression and fusion was significantly higher among patients with cervical fractures (15% *vs.* 5% in patients without cervical fractures, $P<0.001$). Patients who underwent anterior cervical fusion were significantly younger compared to patients who underwent posterior cervical fusion surgery (mean age 56.4 *vs.* 62.9 years, $P<0.001$).

Length of stay and post-hospitalization disposition

For all patients admitted to the hospital, the mean length of stay was 9.8 ± 11.9 days. Patients who were treated surgically had significantly longer length of stay compared to those who were treated non-surgically (13.5 ± 14.0 *vs.* 6.7 ± 8.7 days, $P<0.001$).

Overall, 61% patients were discharged from the hospital to post-acute rehabilitation facility or skilled nursing facility, and 39% were discharged to home. The incidence of discharge to non-home facility was significantly higher in the surgically treated patients (70% *vs.* 53%, $P<0.001$).

In-hospital mortality

The overall incidence of in-hospital mortality in CCS patients was 2.6%. Multivariate logistic regression model adjusted for patient age, gender, Elixhauser comorbidity index, injury severity score, injury mechanism, presence of cervical fracture, initial presentation to a trauma center, and hospital teaching status, revealed that older patient age (OR 1.06, $P<0.001$) and greater Elixhauser comorbidity score (OR 1.72, $P<0.001$) were the two factors that were significantly associated with higher in-hospital mortality in

patients with CCS (15).

Discussion

Management of CCS has evolved with increasing evidence supporting surgical treatment. This study demonstrated the epidemiology and treatment practices of 11,975 cases of CCS presenting to the emergency department from 2009–2012.

CCS was more common in older patients and the average patient age was 60 years old. Males (74.3%) were affected disproportionately more often than females (25.7%). These findings are consistent with previous studies (1,14). The most common cause of injury was a fall. Despite the injury mechanism being low energy, 66% of patients had multiple other injuries and 10% of patients had a concomitant cervical fracture. These findings highlight the importance of maintaining a high index of suspicion and performing a thorough work-up when evaluating patients with CCS.

The majority of patients (89%) were directly admitted to the hospital from the emergency room, 4% patients were transferred to another facility for further treatment and remaining 7% were discharged home from the hospital. It is typically not advisable to discharge these patients from the ED however presumably they had minor symptoms, received adequate education and were involved in shared decision making. The length of hospital stay was nearly twice as long in patients treated surgically versus those treated conservatively. The majority of patients with CCS were discharged to a rehab or skill nursing facility, and as expected patients treated non-operatively were more likely to be discharged home.

In our study, 55% of the patients were treated conservatively, 24.2% were treated with anterior cervical discectomy and fusion (ACDF), 12.5% with a posterior cervical decompression and fusion (PCDF), 6% with a cervical laminoplasty and 2.3% with a combined anterior-posterior procedure. The overall incidence of in-hospital mortality was 2.6%.

Brodell *et al.* reported on 16,134 patients with CCS from 2003–2010 (1). They found a slightly higher proportion of patients treated conservatively in their study period. They reported that 60.6% of patients were treated conservatively, 19.4% with ACDF and 7.5% with PCDF. They did not include patients who were treated with laminoplasty. Yoshihara *et al.* reported on 19,451 patients with CCS

without bony injury from 2000 to 2009 (14). In their study 27.1% patients were treated surgically and there was an increase in rate of operative management throughout their study period. They had an in-hospital mortality rate of 2% in the operative and 2.7% in the non-operatively treated group.

There are several limitations to our study. By nature of utilizing a database we had no information on factors influencing treatment decisions. We did not report on the incidence of concomitant cervical spine fractures which could influence surgical decision making as well. We were limited to outcomes available in the database and information from the patient's hospital stay. We were not able to report on timing to intervention and how that influenced outcomes. Lastly, we were reliant on accurate physician coding of acute CCS. Nonetheless, our study population was similar to previous studies on CCS with regard to patient age, gender and mechanism of injury. We were able to report on treatment patterns which have not been previously described in the literature. Lastly, we did not evaluate the annual trends in treatment however, our study was performed over a relatively short time period compared to previous studies.

In conclusion, our study demonstrates that the majority of patients with CCS were treated non-operatively. Most patients were treated with a decompression and fusion procedure. Cervical laminoplasty was performed in only a minor proportion of cases. Further studies are needed to investigate the impact of these management trends on outcomes.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The study utilized publicly available de-identified data and was exempt from the Institutional Review Board.

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