

# Five Year Mortality Following Central Cord Syndrome in Wales

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## **Abstract**

### *Introduction*

Traumatic central cord syndrome (CCS) is the most common form of incomplete spinal cord injury and represents a significant socioeconomic burden. Most commonly due to a hyperextension injury of the neck, motor impairment affecting the upper limbs more than the lower limbs, with occasional sensory impairment and urinary retention, is seen. Current evidence on mortality and long-term outcomes is limited. The primary aim of this study is to assess the five-year mortality of CCS, and to determine if there is any difference in mortality between management groups or age.

### *Methods*

Patients  $\geq 18$  years that were diagnosed with traumatic CCS between January 2012 and December 2017 in Wales were retrospectively identified. Patient demographics and information regarding their injury, management and outcomes was collected using electronic clinic letters and imaging reports. Statistical analysis was performed to assess mortality and between group differences.

## *Results*

63 patients were identified (66.7% male, mean age 68.8 years). At a minimum of five-years follow-up, 25.4% (n=16) of CCS patients were deceased. 6 (9.5%) patients had died within 31 days of their injury and these patients were significantly older than surviving patients ( $81.7\pm 13.2$  vs  $61.9\pm 17.3$  years, independent samples t-test:  $p < 0.01$ ). 68.3% (n=43) of patients were managed conservatively and there was no significant difference ( $p = .22$ ) in age between conservatively and surgically managed patients. Kaplan-Meier analysis revealed no significant difference in mortality between patients managed conservatively compared to those managed surgically (log rank test,  $p = .175$ ). However, there was a significant difference ( $p < .001$ ) in mortality between the different age groups (<50years vs 50-70years vs >70years). At five years follow up, 50% of the patient group aged >70years at time of injury were deceased.

## *Conclusion*

One quarter of patients with traumatic CCS in Wales were deceased at a minimum of five years following their injury. Almost 10% of patients had died within one month of their injury and these patients were significantly older than their surviving counterparts. We found no significant difference in mortality between patients managed conservatively compared to those managed surgically. Further work needs to be done to assess the long-term functional outcomes of the surviving patients from this study. This will enable doctors to provide patients and their families with more reliable prognostic information and functional recovery predictions.

## Introduction

Traumatic Central Cord Syndrome (CCS) is the most common type of incomplete cervical spine injury and represents a significant socioeconomic burden.(1-3) Damage to the central part of the spinal cord results in motor impairment disproportionately affecting the upper limbs more than the lower, with sensory impairment and urinary retention occasionally seen.(1,4-6) It is most common in older patients following a low velocity hyperextension injury on a background of age-related cervical stenosis.(6,7) However, there is also a peak of younger patients with CCS secondary to a high velocity injury on a background of congenital cervical stenosis.(7)

CCS was first described by Schneider in 1954 and has typically been a clinically diagnosed syndrome.(5) However, more recent studies have suggested various scoring methods to aid in the diagnosis of CCS and its management decision process.(8) Whilst the specifics of its management have been heavily debated, it is agreed that early management is vital in preventing secondary injury and maximising neurological rehabilitation.(9-11)

Historically CCS had demonstrated favourable neurological recovery, but more recent studies have found improved outcomes to be associated with higher educational level, age at time of injury, lower ASIA score on admission, absence of comorbidities and absence of spasticity.(12) Early surgical intervention is recommended, especially for those with moderate to severe CCS.(13,14) However, there are no set guidelines, and the approach differs as per the surgeon and their preference. Whilst conservative management is typically reserved for those with milder CCS, it has been linked to ongoing neuropathic pain.(15)

Many studies have attempted to assess both mortality and the long-term outcomes following traumatic central cord syndrome. However, they have limited follow-up periods and the studies are often inadequately defined and poorly reported. Given the nature of CCS and the long rehabilitation period required, it would be desirable to have more evidence at a follow-up point further into a patient's recovery.

The primary aim of this study was to identify the mortality rates of traumatic CCS at a minimum of five years follow-up. The secondary aim of this study was to identify whether mortality was affected by age group or management type. Our null hypothesis is that there is no mortality risk associated with traumatic CCS diagnosis.

## **Method**

### *Setting*

All patients over the age of 18 who were treated for traumatic central cord syndrome at the Spinal Cord Injuries Centre Wales between January 1<sup>st</sup> 2012 and December 31<sup>st</sup> 2017 were identified. Duplicates were collated under one entry and patients with incomplete records or those not meeting the inclusion criteria were excluded. Participants who were diagnosed with central cord syndrome not resulting from trauma, for example tumour, spontaneous haematoma, inflammation, or an isolated myelopathy, were excluded. All patients had an injury to the cervical spine, and clinically exhibited disproportionately greater motor impairment in the upper limbs than the lower limbs, with or without sensory impairment or urinary retention.

Patients may have had evidence of extrinsic compression, such as fracture, haematoma and/or acute disk instability.

### *Data Collection*

Data was collected at a minimum of five years following CCS diagnosis. Data was obtained using electronic clinic letters and imaging records. Collected variables included; patient demographics, date of injury, surgical or conservative management, date of referral, admission and discharge, ASIA score on admission, discharge and at the last follow up, and the date of the last follow up.

### *Statistical Analysis*

Statistical analysis was performed using SPSS version 26. Between group differences were assessed using independent samples t-tests, whilst Kaplan-Meier analysis and the log rank test were used to look at patient mortality.

## **Results**

A total of 63 patients met the inclusion criteria for this study. There were 42 (66.7%) males and 21 (33.3%) females, with a mean age of 68.8 years (standard deviation (SD): 16.5, range: 26 to 105). The average age at time of injury was 63.8 years (SD: 17.9, range: 19 to 105). Patients were divided into three age groups (<50 years, 50-70 years, >70 years), as suggested

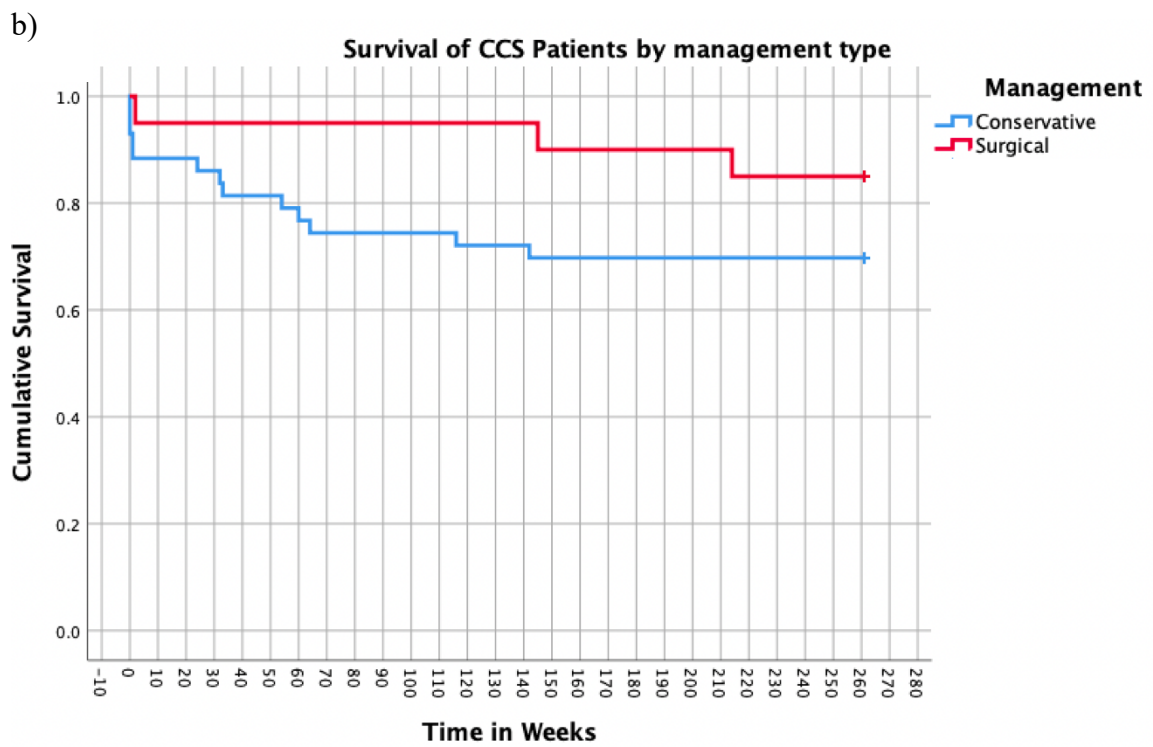
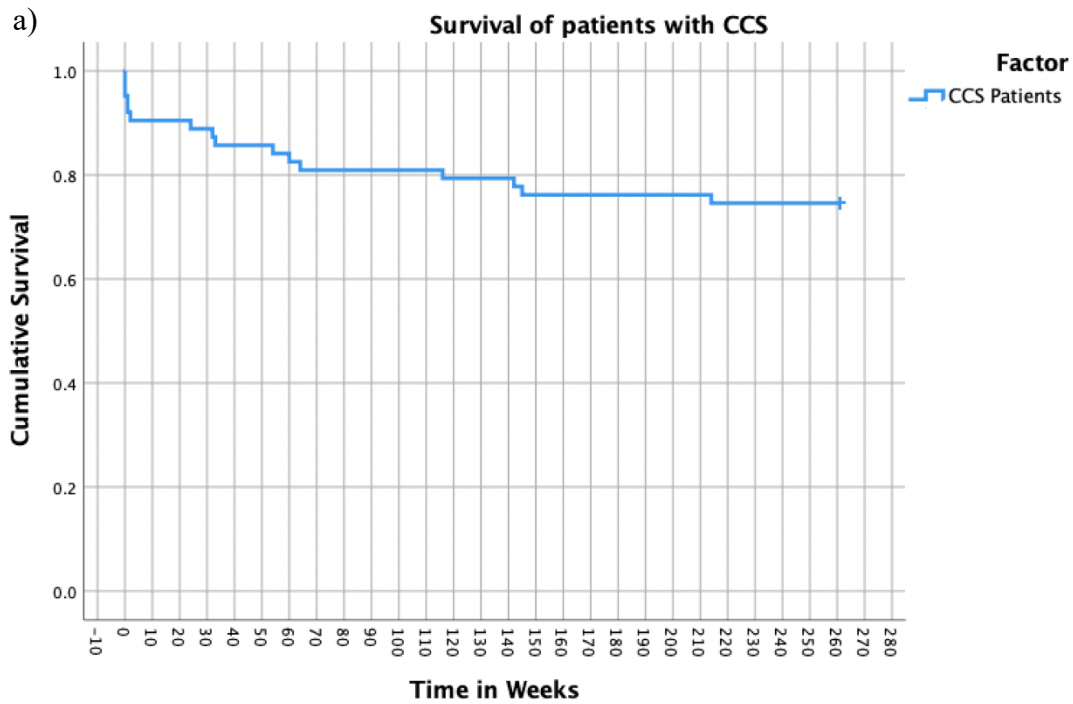
in other studies.(6,16) 13 patients (20.6%) were less than 50 years of age at the time of their injury, 26 (41.3%) were aged 50 to 70 years and 24 patients (38.1%) were older than 70.

Data was collected at an average of 6.1 years (SD: 1.2) following the date of injury. There was a minimum of five years follow up post-injury (as per inclusion criteria) and a maximum of nine years. At the point of data collection, 25.4% (n=16) of patients were deceased. Of the patients that died, 6 (37.5%) had passed away within one month of their injury occurring. The mean age of patients that died within 31 days of their injury was 81.7 years (SD: 13.2), which was significantly different to the mean age of patients that survived ( $81.7 \pm 13.2$  vs  $61.9 \pm 17.3$  years,  $p < 0.01$ , independent samples t-test).

The majority of patients (68.3%, n = 43) were managed conservatively, with only 20 patients (31.7%) receiving surgical intervention. The mean age at injury for conservatively managed patients was 65.7 years (SD: 18.7, range: 20 to 105) and the mean age of patients managed surgically was 59.7 years (SD: 15.6, range: 36 to 88). Although the patients who underwent surgery were on average 5 years younger than those who were managed conservatively, the difference was not significant ( $p = .22$ ).

At 5 years follow-up, thirty (69.8%) conservatively managed patients survived, while seventeen (85.0%) surgically managed patients survived. Kaplan-Meier analysis comparing the survival rates of patients in the two treatment groups revealed no significant difference in mortality between the two groups in our study (log rank test,  $p = .175$ ). However, there was a significant difference in mortality between the three age groups (<50 years vs 50-70 years vs >70 years) (log rank test,  $p < .001$ ). 100% of patients who were less than 50 years old at the time of their injury were alive at five years post-injury. Our analysis showed that patients aged

between 50 and 70 had an 84.6% chance of survival at five years post injury. However, most significantly, those aged 70 years or older at the time of injury had a 50% chance of survival at five years post injury. Results from the Kaplan-Meier analysis is shown in Figure 1.



c)

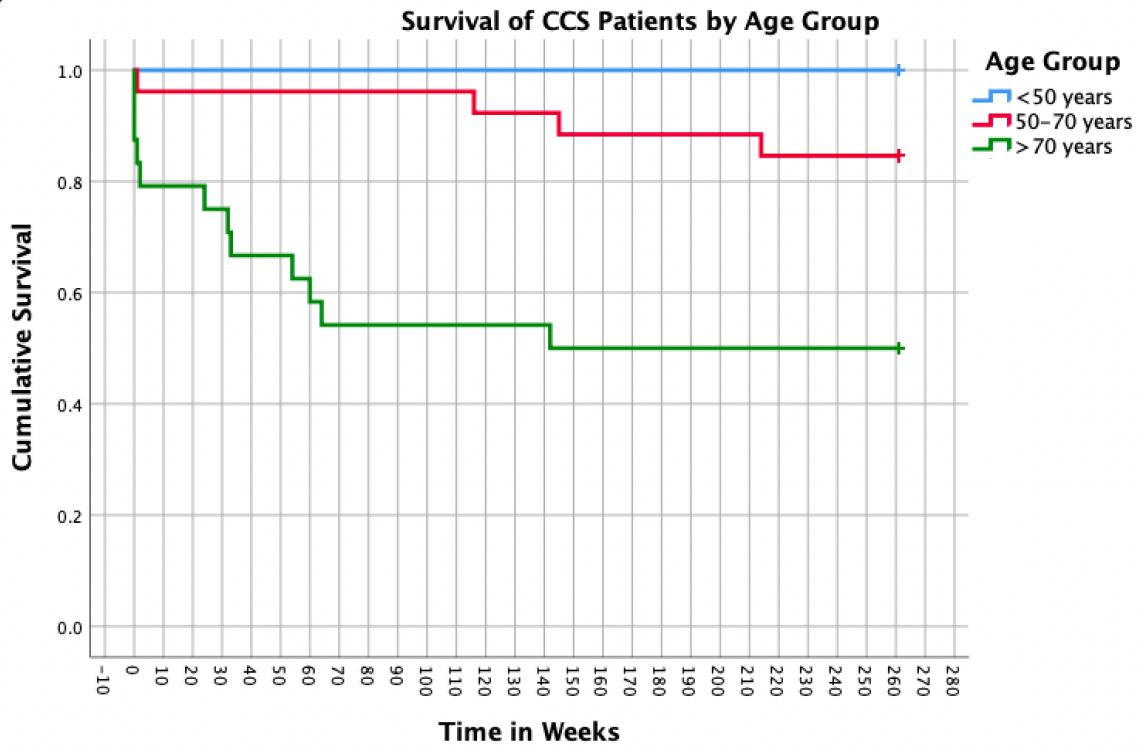


Figure 1. Kaplan-Meier graphs showing the cumulative survival of patients with central cord syndrome (CCS) over a five-year follow-up period from time of injury.

- a) Survival of all patients with CCS
- b) Survival of patients with CCS depending on management type (conservative vs surgical)
- c) Survival of patients with CCS depending on age group (<50 years vs 50-70 years vs >70 years)



## Discussion

Our retrospective study of patients in Wales that were diagnosed and treated for traumatic central cord syndrome between January 1<sup>st</sup> 2012 and December 31<sup>st</sup> 2017 showed that at a minimum of five years follow up, one quarter of patients were deceased, with ten percent of patients having died in the first thirty-one days following their injury. Additionally, our results showed no significant difference in mortality between those patients that were managed conservatively and those that received surgical intervention. However, there was a significant difference in mortality between the different age groups, with an age of greater than 70 years at the time of injury associated with a 50% survival rate at five years.

Two thirds of the patients in our study were male. Although reasoning for this is not explored in the literature, our findings are consistent with many other studies that have similarly overwhelmingly male cohorts.(9,10,17,18) Increasing age is also a common theme noted in both our findings and other studies.(19) Age related patterns of injury have been documented, with traumatic CCS in patients over 50 years of age most commonly due to hyperextension injuries on a background of age-related cervical stenosis.(6,7) The prevalence of CCS is only likely to increase further, given the current aging population and their increased risk of trauma and its complications.(3,20)

It is clear in the literature that increasing age is generally associated with increased mortality and poorer long-term functioning.(21-25) Our results showed a significant difference between the age of patients that had died within 31 days of their injury, compared to those who had survived. Despite other studies citing lower mortality rates, such as 2.6%, there is consensus

on the association between increasing age and increasing mortality.(18,22,24) This is most likely explained due to the presence of comorbidities and the lower baseline level generally seen in the older population group.(17,18,20) Brodell et al. noted comorbidities such as congestive heart failure, coagulation deficiencies, diabetes mellitus and weight loss to be associated with significantly higher mortality in elderly patients with CCS.(18) They also suggested that such factors increase the risk of post-operative complications and as such should be taken into account in the management decision process. (18)

There has been much debate over the years regarding the optimum management of CCS.(26-29) Not only has the role of surgical intervention been questioned, but it's timing also scrutinised. A recent large prospective multi-centre study concluded that early surgery (within twenty-four hours of injury) is associated with improved neurological outcome.(9) The STASCIS study demonstrated low overall mortality, with only one (0.003%) patient death in the first 30 days post injury.(9) However, this study was assessing all spinal cord injuries and not CCS exclusively and so would have included more younger patients who are more likely to have favourable outcomes. This may explain why they demonstrated such encouraging mortality rates. Additionally, their lack of a control group or inclusion of any conservatively managed patients and their restricted follow-up period of six months, limits their results. Given the long and often drawn-out nature of recovery following spinal cord injury, we suggest a period of greater than six months is required to draw more reliable conclusions.(2) Other studies have shown that the timing of surgery does not influence mortality rates in patients with CCS, but it is suggested that, consistent with the STASCIS study findings, earlier surgery can result in improved neurological and discharge outcomes.(10,11,13) However, these studies, as with many assessing the long-term outcomes of CCS, are limited by their follow-up time period. Our study achieved a minimum of five year follow-up for all patients, allowing the opportunity

to assess the long-term mortality rates following CCS. Our results showed no significant difference in mortality when comparing the conservative and surgical management of patients with CCS. However, more patients that were managed conservatively died than those that were managed surgically, and conservatively managed patients that died, tended to die sooner. It is difficult to accurately conclude the reason for this, but we suggest this could be down to individual patient status and preference. Older patients with more comorbidities or those with very severe neurological deficits are more likely to be managed conservatively, especially given the specific risks associated with spinal surgery.(30) Additionally, our results did show that patients who were managed conservatively were on average five years older than those who received surgical intervention. This is consistent with findings from Godzik et al. which state that despite the shift towards the surgical management of patients with CCS in recent years, there is a link between increasing age and decreasing surgical prevalence.(11)

One quarter of our patients were deceased at a minimum of five years following their injury and almost 10% of patients had died within one month. These mortality rates are greater than those reported in other studies. Two studies quote an overall in-hospital mortality of 2.6%.(18,22) Although it is difficult to explain this difference, we suggest that our follow-up period is significantly longer than the majority of other studies, thus allowing us the opportunity to assess patients further into their recovery period, increasing the chance that we will report more deaths. Another consideration is that evidence shows the Welsh population to be 'sicker', with a lower life expectancy compared to other parts of the United Kingdom.(31) Additionally, other studies tend to focus on mortality in only surgically managed patients. We therefore suggest that these studies may have excluded many patients who passed away, as they were never offered surgical management due to their poor chance of survival.

Most significantly, we found that half of the patients who were over 70 years at the time of injury were deceased at five years follow-up. More promising results were seen for younger patients, with 100% survival for patients younger than 50 years at time of injury, and only 15% chance of death in patients aged between 50 and 70 years. This is consistent with other studies which have shown that older age is associated with less favourable outcomes.(6,21-24) Many studies have assessed the mortality rates associated with other common traumatic injuries in the elderly, such as hip fractures, wrist fractures and odontoid peg fractures.(32,33) Venkatesan et al. found a mortality of 37.5% at one year following odontoid peg fracture, whilst the mortality at one year following hip fracture is typically quoted at around 30%.(32,33) However, these studies used a cut off of 65 years and above and did not assess mortality to five years post injury, so are not directly comparable to our results. However, we can suggest that the mortality following CCS is worse than other traumatic injuries commonly experienced by the elderly population, with 50% of patients 70 years or older at time of injury deceased after five years.

One major strength of this study is the minimum five year follow-up period, which allowed us to assess the long-term outcomes and mortality of traumatic CCS patients in Wales. However, limitations included the retrospective nature of the study which posed difficulties when collecting data, as not all information was readily available. Furthermore, our study is relatively underpowered due to the relatively small number of CCS patients, thus limiting the conclusions we can draw from our results.

## **Conclusion**

Our results show that one quarter of patients diagnosed with traumatic CCS in Wales were deceased at a minimum of five years following their injury. Ten percent of CCS patients had

succumbed within 1 month of their injury, and these patients were significantly older than their surviving counterparts. There was a significant difference in mortality between the different age groups, with 50% of patients >70 years old at time of injury deceased within five years. However, we found no significant difference in mortality between conservative and surgical management. Whilst our results give a guide to five-year mortality following traumatic CCS, in future work we aim to follow-up the surviving patients with a questionnaire and in person assessment in order to determine their long-term functional outcomes. These results, combined with the ones from this study, will allow doctors the ability to provide patients and their families with more reliable prognostic information and functional recovery predictions.

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