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The Effect of COVID-19 National Lockdown on the Time from Presentation to Surgery of Patients with Suspected Cauda Equina Syndrome: Two UK Tertiary Centers' Study

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■ **OBJECTIVE:** To investigate if COVID-19 UK lockdown measures resulted in a delay in the presentation and treatment of patients with cauda equina syndrome (CES).

■ **METHODS:** This is a multicenter retrospective study of patients with surgically treated CES across 3 time periods: April–May 2020 (first lockdown), August–September 2020 (no-lockdown group), and January–February 2021 (second lockdown). Data regarding duration of symptoms, time from referral to admission, time from admission to surgery, and postoperative outcomes were collected.

■ **RESULTS:** A total of 56 patients (male: 26, female: 30, mean age: 44.3 years) were included in the study ($n = 14$, $n = 18$, and $n = 24$ in the 3 time periods, respectively). There was no significant difference in duration of symptoms across the time periods (12.6 days vs. 8.2 days vs. 3.8 days) ($P = 0.16$). Nearly all the patients were admitted within 48 hours of referral ($n = 55$, 98.2%). The majority of patients were operated on within 48 hours: first lockdown ($n = 12$, 85.7%), no-lockdown ($n = 16$, 88.9%), and second lockdown ($n = 21$, 87.5%). The length of hospital stay was significantly shorter in the second lockdown (3.3 days) versus the other 2 time periods (4.4 days and 6.4 days) ($P = 0.02$). Thirteen complications were present, with dural tear being the most common ($n = 6$, 10.7%). Majority reported symptom improvement ($n = 53$, 94.6%), with a similar number discharged home ($n = 54$, 96.4%).

■ **CONCLUSION:** Despite the pandemic, patients with CES were promptly admitted and operated on with good

outcomes. Shorter duration of hospital stay could be attributed to adaptation of spinal services.

INTRODUCTION

Cauda equina syndrome (CES) is a major time-critical emergency in spine surgery with an incidence of 0.3–0.5 per 100,000 per year.^{1,2} It presents with wide-ranging symptoms such as back pain, bilateral or unilateral sensory motor dysfunction, bowel or bladder incontinence/retention, and sexual dysfunction. Missed diagnosis has serious medicolegal implications for not only the treating team but also the National Health Service (NHS) trusts; therefore, it is important to act on this as per national guidelines published by the British Association of Spinal Surgeons (BASS)³ and Society of British Neurological Surgeons.⁴ However, the COVID-19 pandemic has mandated unprecedented situation in which spine surgeons among other health care professionals were asked to reshape services to limit viral spread and spare hospital resources.

Surgery is considered as the cornerstone of treatment in incomplete CES and CES with retention; latter is defined as painless retention with overflow incontinence and loss of bladder function.⁵ However, there is no agreed consensus regarding the “ideal” time for surgery in these patients. Good quality published evidence has suggested that similar outcomes have been observed with surgery up to 48 hours after the onset of symptoms.^{1,6,7} However, of significance is that decompression within 48 hours of autonomic symptoms has shown significant improvements in the recovery of bowel and bladder dysfunction

Key words

- Cauda equina syndrome
- COVID-19
- Multicenter
- Outcome
- Surgical decompression

Abbreviations and Acronyms

BASS: British Association of Spinal Surgeons

CES: Cauda equina syndrome

NHS: National Health Service

SD: Standard deviation

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compared with later groups.^{8,9} Pre-COVID national data regarding CES have been thoroughly studied.¹ However, it was hypothesized that there would be the potential for CES waiting time to worsen during the COVID pandemic as the NHS services have been stretched and the potential for missed cases could increase; early evidence however seems to disagree.^{10,11} There was no regional reduction in referral for CES nor in those requiring decompression.^{10,11} However, the timescale from referral to surgery has not been addressed.

The effect of the COVID-19 pandemic has led to changes to the restructuring of spinal services in certain regions; however, we are still evolving to optimize these pathways.¹² These changes may have affected patients with CES and led to delay in surgical intervention. As such, our aim was to assess the effect of COVID-19 national lockdown on the time from presentation to hospital admission to surgery and the clinical outcomes of patients with confirmed CES across 2 tertiary trauma centers, one in Wales and the other in South-Central England. We aimed to examine how COVID-19 impacted on cauda equina surgery services to inform the literature and enlighten hospital management systems with the key information needed to drive strategies to cope with future expected waves.

MATERIALS AND METHODS

A retrospective multicenter cohort study and analysis of data from 2 large UK centers (Wessex Spinal Unit, University Hospital Southampton and Neurosurgery Department, University Hospital of Wales, Cardiff) was conducted in order to explore the effects of the COVID-19 pandemic and lockdown measures on the presentation, admission, and management of patients with suspected CES. This study was a registered audit with the respective local institutions gaining institutional ethical approvals.

Data Collection

The study duration was across 3 time periods with each of them being 2 months in duration. The first period was April and May 2020 during which the first national lockdown measures were applied. The second period was August and September 2020 during which no lockdown measures were applied. The final period was January and February 2021 during which the second national lockdown measures were applied.

Data were collected in both centers using a standardized proforma and were entered electronically into a protected spreadsheet that complies with data protection regulations. Electronic and

Table 1. Demographic of Study Population

Group	Subgroup	April–May 2020		August–September 2020		January–February 2021	
		n	%	n	%	N	%
Sex	Male	8	57.1	10	55.6	8	33.3
	Female	6	42.9	8	44.4	16	66.7
	Total	14		18		24	
Age (years)	<20	0	—	1	5.6	0	—
	20–39	3	21.4	10	55.6	10	41.7
	40–59	8	57.1	7	38.9	9	37.5
	60–75	3	21.4	1	5.6	5	20.8
	>75	0	—	0	—	0	—
Presentation	CESI	12	85.7	13	72.2	19	79.2
	CESR	2	14.3	5	27.8	5	20.8
	Other	0	—	1	5.6	0	—
Symptoms	Bladder/bowel	11	39.3	10	37.0	15	44.1
	Weakness	10	35.7	4	10.8	7	20.6
	Saddle anesthesia	5	17.9	7	18.9	10	29.4
	Other	2	7.1	6	16.2	2	5.9
Level affected	L2/3	0	—	1	5.6	0	—
	L3/4	3	21.4	2	11.1	4	16.7
	L4/5	6	42.9	9	50.0	11	45.8
	L5/S1	5	35.7	7	38.9	9	37.5

CESI, cauda equina syndrome incomplete; CESR, cauda equina syndrome with retention.

paper patient records, referrals from accident and emergency departments and/or general practice through the electronic referrals database (referapatient.org), theatre records, and operation notes were consulted. The study was registered with the respective local institutions.

Data collected included demographics, presenting symptoms, duration of symptoms, time from symptom onset till presentation, time from presentation to admission on a neurosurgical ward, time from admission till surgery, COVID-19 status, surgical management, and postoperative outcomes. All patients had a lumbosacral magnetic resonance imaging before a thorough general and neurosurgical workup with other causes of the presenting symptoms excluded.

Statistical Analysis

Data were analyzed using GraphPad Prism Version 8 (San Diego, California, USA), and the Kruskal-Wallis analysis was used to compare data among the 3 groups. A *P* value of <0.05 was considered significant.

RESULTS

The total number of patients analyzed across the time periods for the 2 centers was 57 (male: 26, female: 31), with the mean age being 44.3 years (range: 20–71 years). All patients included in the study were operated on ($n = 56$). Further breakdown is provided in **Table 1**. The most common symptoms were bowel/bladder disturbance ($n = 36$), saddle anesthesia ($n = 22$), and lower limb weakness ($n = 21$). The most common level affected was L4/5 ($n = 26$, 46%).

Time from Symptoms Onset to Presentation to Hospital

The total mean duration from the start of symptoms to hospital presentation was 8.2 days (range: 1–90 days). The duration of symptoms reduced from 12.6 days (standard deviation [SD] = 17.71) in the first lockdown to 8.2 days (SD = 20.96) in the no-lockdown phase and then to 3.8 days (SD = 3.67) in the second lockdown ($P = 0.16$). Further information is provided in **Figure 1**.

Time from Referral to Admission to Neurosurgical/Spinal Center

The median duration from referral to admission to neurosurgery ward was <24 hours (range: 82 minutes–3 days), with the breakdown provided in **Figure 2**. The majority of the patients were admitted into the tertiary neurosurgical center within 24 hours of referral at both centers ($n = 36$, 64.3%), with nearly all being transferred within 48 hours ($n = 55$, 98.2%).

It took >48 hours for admitting 1 patient to the ward because safe transfer of the patient from a high-security prison was awaited.

Time from Admission Under Neurosurgery/Spinal Surgery to Operation

The median duration from time of admission under the neurosurgical/spinal team to operation was <24 hours (range: 69 minutes–17 days), with the breakdown provided in **Figure 3**. The majority of the patients were operated within 48 hours of admission to the ward ($n = 49$, 87.5%).

Time from start of symptoms to presentation to hospital (Duration of symptoms)

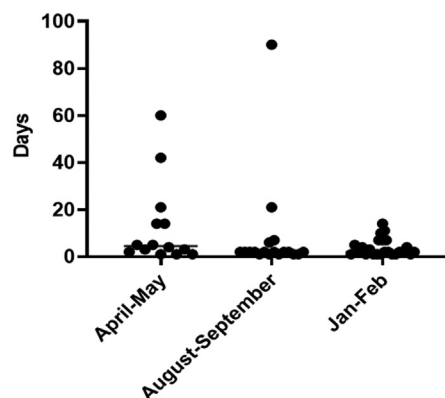


Figure 1. Breakdown of start of symptoms to presentation to hospital across the studied time periods. Each dot represents a patient.

Seven patients were operated on >48 hours after admission to the ward, the reasons being symptoms ongoing for more than 2 months ($n = 4$), ongoing respiratory compromise ($n = 1$), delayed progression of symptoms once admitted to the ward ($n = 1$), and no reason documented for delay ($n = 1$).

Postoperative Outcome

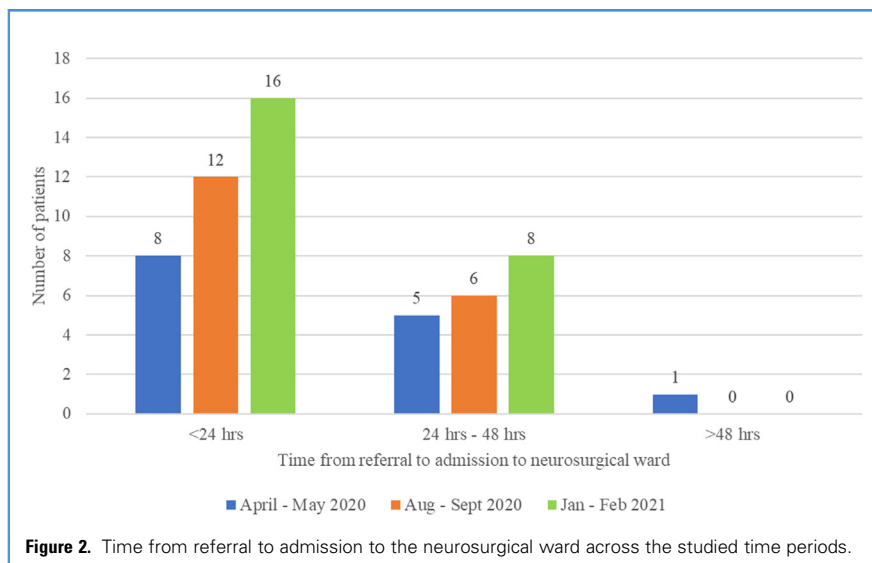
The total length of hospital stay was 4.7 days (range: 2–21 days). This was longer in the no-lockdown period (6.4 days) versus the 2 lockdown periods (4.4 and 3.3 days, respectively), as shown in **Figure 4**. The length of stay was significantly shorter in the second lockdown when compared with the other time periods ($P = 0.02$, Kruskal-Wallis multiple comparison test).

Twelve patients had complications (21.4%), with the most common being dural tears ($n = 6$, 10.7%). Other complications were as follows: deep venous thrombosis ($n = 1$, 1.8%), arachnoiditis ($n = 1$, 1.8%), urosepsis ($n = 1$, 1.8%), fractured drain ($n = 1$, 1.8%), COVID-19 ($n = 1$, 1.8%), and readmission with reoperation due to wound leak ($n = 1$, 1.8%). The number of complications was small and as such unable to be compared between the 3 time points studied.

Patient-reported symptom improvement was noted before discharge in nearly all the patients ($n = 53$, 94.6%), and no patients reported worsening of symptoms after operation. The majority of patients were discharged home after physiotherapy and occupational therapy input with community follow-up if required ($n = 54$, 96.4%); however, 2 patients required further rehabilitation because of poor mobility (3.6%) and 1 patient returned back to prison (1.8%).

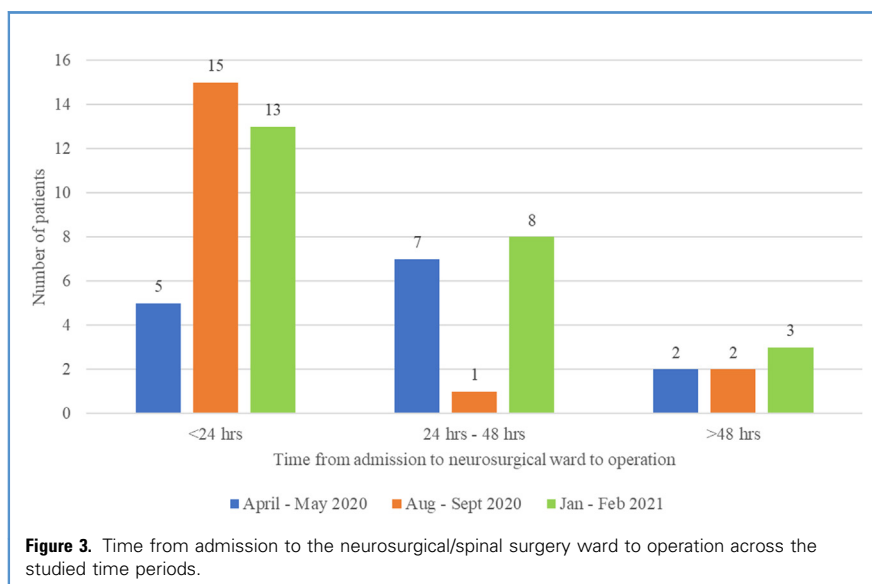
DISCUSSION

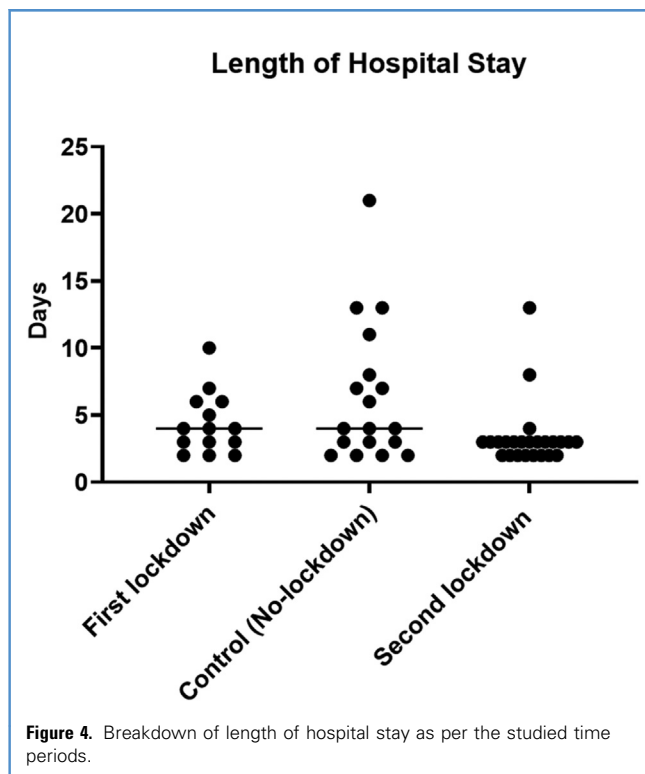
CES has a significant impact on patients' quality of life and causes significant mental, physical, and psychological issues. Work has been performed in the past to implement a referral pathway for CES; however, this was in the pre-COVID environment.^{1,13}



Our cohort shows a progressive increase in the number of CES cases throughout the 3 time periods, which is unlike other studied articles.^{10,11} This could highlight the effect of introducing vaccinations and the reduction of governmental restrictions causing more people to have access to health care and appropriate support. However, this being said, the first vaccination in the United Kingdom was on December 8, 2020, and it was primarily offered to those who were vulnerable or worked within health care and moved down through age groups and risk levels.^{1,14} Our population had a mean age of 44 years; thereby, the increase in number cannot be made attributable to vaccination status. A survey of the Office for National Statistics across Great Britain emphasized that younger people were less

likely to be “very worried” about the effect of coronavirus on their lives than those over 60 years of age, and this attitude could reflect the age within our study population.¹⁵ Therefore, there may have been those 60 years or above who were missed in this window and might have been referred to the urology clinic or outpatient spinal services. In addition, acute CES affects young patients because of the fact that young people have healthy discs, whereas older patients present with stenosis-type symptoms rather than acute CES. After the first national lockdown, patients were encouraged by the NHS and the UK government to seek medical advice and attend accident and emergency departments when needed. This perhaps had a role in increasing the number of patients in our study.





Importantly, there was a decrease in duration of symptoms to hospital presentation through the time periods, from 12.6 days at the first lockdown to 3.8 days at the second lockdown (Figure 1). This highlights that services became more streamlined the more we understood about COVID-19. BASS suggested that spinal hub centers should work across the region, ensuring equal access of health care for patients.³ This initiative alongside the work from local health boards has led to the creation of elective “green zones” and emergency/trauma “amber zones”; the latter would be where incomplete CES or CES with retention patients are admitted.¹² This initiation could have also led to a higher number of patients being admitted to neurosurgical wards within 24 hours, which was double the number compared with the initial lockdown (Figure 2). Generally, patients with suspected CES attending general practitioners’ clinics or spinal triage services/hubs are referred/admitted under neurosurgery services at both tertiary centers.

Guidelines regarding optimal time for operation after CES are controversial mainly due to varying definitions of starting points used to calculate “time of surgery.”^{1,16} Even though performing surgery earlier is desirable, as it theoretically causes less nerve compression, thereby increasing neurological recovery, there was no statistically significant proof that delaying up to 48 hours after onset or worsening of symptoms is detrimental.^{6,17} On the contrary, a published systematic review highlighted that there is no strong basis to support 48 hours as a safe time period to delay surgery and instead it should be done as soon and safely as possible⁵; however, some findings were extrapolated from animal models to reach this conclusion. In addition, a large

series with over 20,000 patients with CES highlighted improved inpatient complications and mortality rates in those operated on day 0 or day 1 of admission; however, a link with symptom onset and timing of surgery would be interesting to note.¹⁸ This heterogeneity in data highlights the need for a large-scale international clinical study that aims to clearly address this problem; this is especially pertinent during the times of bed crises like many countries in the world faced during the pandemic. Despite these differences, the 48-hour time scale is still a favored operative time period used for patients with CES.

In our series, there were no significant delays in operating time observed with nearly 88% of cases being operated on within 48 hours of onset of symptoms, with nearly all patients being discharged home postoperatively (96.4%) with “satisfactory” patient-reported outcomes. This confirms the abilities of neurosurgical/spinal service units in the United Kingdom to accommodate increasing demands appropriately, especially during the pandemic. There was also variation in hospital stay after decompression for CES across the time periods (Figure 4). The average postoperative duration of hospital stay was 4.7 days; however, the length of stay was significantly shorter in the second lockdown (3.3 days; SD: 2.4) compared with the control group (6.4 days; SD: 5.2) and first lockdown (4.4 days; SD: 4.3) ($P = 0.02$). This might be due to streamlining of the services following advice not only from BASS and Society of British Neurological Surgeons initiatives but also from published evidence of other UK centers also facing problems with bed capacity. It is important to highlight that there was no discernable difference in patient outcomes in the 3 time periods with complication rates similarly spread, suggesting that clinical acumen and surgical skill had not reduced during the lockdown periods of reduced activity. The advent of webinars, virtual meetings, and e-learning would have helped consolidate gaps in operative and clinical knowledge during these times. This, along with virtual or augmented reality, could further medical education in years to come by improving anatomical knowledge and surgical skills and is something that will progress hugely thanks to the pandemic.

CONCLUSION

The pandemic has affected service provision throughout the United Kingdom. At a time when resources are scarce, it is important that outcomes for patients with CES do not deteriorate. Our multicenter retrospective study highlights that the more we move further away from the start of the pandemic, the more streamlined our services become. This offers the opportunity to provide a flexible pathway that ensures that people have access to adequate spinal care. We have found that despite the pandemic, our population exhibited outcomes parallel to the pre-COVID era with shorter hospital stays throughout the time periods; this has also helped us realize the potential of webinars, online conferences, and virtual reality to augment the operative learning experience for trainees in a time like this.

CRedit AUTHORSHIP CONTRIBUTION STATEMENT

Mohammad Baraka: Data curation, Writing – review & editing, Approval of final manuscript. **Adithya Varma:** Visualization, Writing – original draft, Approval of final manuscript. **Isaac Mayo:** Data curation, Approval of final manuscript. **Ravindra**

Nannapaneni: Formal analysis, Writing – review & editing, Approval of final manuscript. **Stephen McGillion:** Formal analysis, Writing – review & editing, Approval of final manuscript. **Emad Shenouda:** Formal analysis, Writing, Approval of final manuscript. **Ali Nader-Sepahi:** Formal analysis, Writing, Approval of final

manuscript. **Christopher Dare:** Formal analysis, Writing, Approval of final manuscript. **Malik Zaben:** Conceptualization, Writing – review & editing, Supervision, Approval of final manuscript. **Anan Shtaya:** Conceptualization, Formal analysis, Writing – review & editing, Supervision, Approval of final manuscript.

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