



A CLINICO-RADIOLOGICAL STUDY AND ROLE OF EARLY SURGERY IN CAUDA EQUINA SYNDROME: A TERTIARY CENTRE EXPERIENCE AND OUTCOME

Neurosurgery

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ABSTRACT

Background: Cauda equina syndrome (CES) is a neurosurgical emergency associated with significant morbidity if diagnosis and surgical decompression are delayed. Prognosis differs between incomplete CES (CES-I) and CES with urinary retention (CES-R), with surgical timing playing a key role in recovery. **Methods:** We conducted a prospective single-institution cohort study of 44 patients with CES (May 2022–August 2025). Patients were categorized as CES-I or CES-R. Surgical timing was stratified as within 48 hours or beyond 48 hours. Outcomes at 1 year were assessed across motor, sensory, bladder, bowel, and sexual domains. Statistical analysis was performed using chi-square tests ($p < 0.05$). **Results:** Of 44 patients (mean age 47.2 years; 59% male), 28 (63.6%) had CES-I and 16 (36.4%) had CES-R. Lumbar disc herniation was the most common etiology (61%), followed by trauma (18%), tumors (11%), and infection (7%). In CES-I, early decompression (<48 h) resulted in significantly higher complete recovery (82.4%) compared with delayed surgery (36.4%) ($\chi^2 = 4.31$, $p = 0.038$). CES-R patients showed poorer outcomes, though some recovery was observed in both early and delayed groups. At one year, 68% regained independent ambulation and 59% achieved satisfactory bladder control. However, 46% reported persistent neuropathic pain and 32% had sexual dysfunction. **Conclusion:** Outcomes in CES are primarily determined by neurological status at presentation and surgical timing. Patients with CES-I benefit most from decompression within 48 hours, while CES-R generally carries a less favorable prognosis regardless of timing. Despite timely surgery, residual morbidity is common, highlighting the importance of long-term follow-up and rehabilitation strategies.

KEYWORDS

Cauda Equina Syndrome, CES-I, CES-R, Surgical Timing, Bladder Dysfunction

INTRODUCTION

Cauda equina syndrome (CES), first described by Mixter and Barr in 1934 [2], is a severe form of nerve root compression involving the lumbosacral roots, leading to bladder, bowel, sexual, motor, and sensory dysfunction [1,13]. Although rare, with an estimated incidence of 1–3 per 100,000 annually [3], CES carries high morbidity if diagnosis and surgical decompression are delayed. The most common etiology is lumbar disc herniation, but trauma, tumors, infection, and iatrogenic causes also occur [4]. Magnetic resonance imaging (MRI) remains the gold standard for the diagnosis of cauda equina syndrome, as it provides detailed visualization of neural compression and the underlying pathology, thereby guiding timely surgical intervention. In situations where MRI is unavailable or contraindicated, computed tomography (CT) myelography serves as a valuable alternative for identifying compressive lesions [5]. Early diagnosis and decompression are considered critical; multiple studies and reviews suggest better outcomes if surgery occurs within 48 hours of symptom onset [6,7]. However, some debate persists regarding exact timing [8]. Prognosis differs between incomplete CES (CES-I) and CES with painless urinary retention (CES-R).

Historically, outcome reporting has focused on bladder dysfunction, but recent work emphasizes the significance of motor, sensory, bowel, and sexual recovery for quality of life and return-to-work [9,10]. Long-term follow-up studies demonstrate that residual deficits remain common, even with timely surgery [11,12].

This study presents a single-institution cohort of 44 patients with CES, assessing risk factors, surgical timing, and multidomain outcomes, with emphasis on motor and sensory recovery in addition to bladder, bowel, and sexual function.

MATERIALS AND METHODS

We conducted a prospective single-institution cohort study between May 2022 and August 2025. Forty-six patients with CES underwent surgical management, with two lost to follow-up, leaving 44 for analysis. Patients included in the study were those diagnosed with cauda equina syndrome based on characteristic clinical features such as bladder or bowel dysfunction, saddle anesthesia, and bilateral lower limb weakness or sensory loss, with radiological confirmation of neural compression on MRI or CT myelography, and age above 18

years. Patients were excluded if they had incomplete clinical or radiological records, a history of prior lumbar spine surgery, non-compressive causes of CES (such as demyelinating disorders or infection without compression), or were lost to follow-up. Data included demographics, presenting symptoms, MRI findings, etiology, surgical timing, and outcomes. Patients were categorized into CES-I and CES-R. Timing of surgery was stratified into <48 h and >48 h. Outcomes at 1 year were evaluated. Statistical significance was assessed using chi-square tests with $p < 0.05$ considered significant. Ethical approval was obtained from the institutional ethics committee.

RESULTS

A total of 44 patients with Cauda Equina Syndrome (CES) were included, with a mean age of 47.2 years (range 21–68) and a male:female ratio of 1.5:1 (59% male). Based on presentation, 28 patients (63.6%) had incomplete CES (CES-I), while 16 (36.4%) presented with CES-R. All patients reported urinary symptoms (100%). Saddle anesthesia was noted in 29 (65.9%), bilateral sciatica in 23 (52.3%), and motor weakness in 21 (47.7%).

The most common etiology was lumbar disc herniation (27 patients, 61%), followed by trauma in 8 (18%), spinal tumors in 5 (11%), and infection in 3 (6.8%). Among the 27 lumbar disc cases, included L4–L5 in 15 (55.6%), L5–S1 in 7 (25.9%), and multilevel in 5 (18.5%).

At one year, 46% had neuropathic pain and 32% had persistent sexual dysfunction.

Table 1. Clinical Features at Presentation (n=44).

Clinical feature	Patients (n)	Percentage (%)
Urinary symptoms	44	100.0
Saddle anesthesia	29	65.9
Bilateral sciatica	23	52.3
Motor weakness	21	47.7

Table 2. Etiology of CES (n=44).

Etiology	Patients (n)	Percentage (%)
Lumbar disc herniation	27	61.4
Trauma	8	18.2
Spinal tumor	5	11.4
Infection	3	6.8

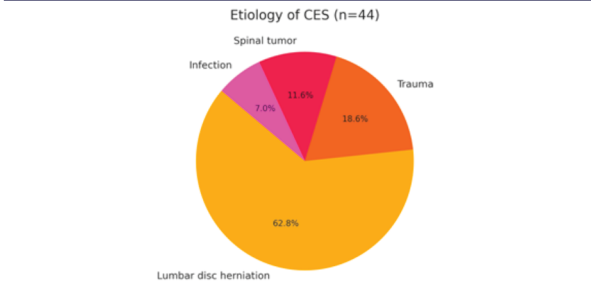


Figure 1. Etiology of CES.

Table 3. Levels of Lumbar Disc Herniation (n=27).

Disc level	Patients (n)	Percentage (%)
L4–L5	15	55.6
L5–S1	7	25.9
Multilevel	5	18.5

Table 4. Combined Outcomes of CES-I and CES-R by Timing of Decompression

Timing	CES-I: Complete	CES-I: Partial/No	CES-R: Complete	CES-R: Partial	CES-R: None
<48h	14	3	3	4	1
>48h	4	7	2	3	3

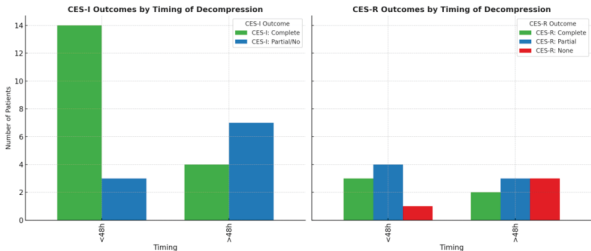


Figure 2. Recovery Outcomes in CES-I and CES-R by Timing of Surgery.

Table 5. One-year Outcomes (n=44).

Outcome	Patients (n)	Percentage (%)
Independent ambulation	30	68.2
Satisfactory bladder function	26	59.1
Persistent neuropathic pain	20	45.5
Sexual dysfunction	14	31.8

DISCUSSION

Outcomes in cauda equina syndrome (CES) are primarily determined by the neurological status at presentation and the timing of surgical decompression. Patients presenting with incomplete CES (CES-I) demonstrated significantly better recovery when operated upon within 48 hours, whereas those with CES-R showed generally poor outcomes regardless of surgical timing—a finding corroborated by regression model analyses in Indian CES cohorts [14]. Lumbar disc herniation predominated, followed by trauma, tumors, and infections.

Despite timely decompression, substantial residual morbidity remained, particularly affecting bladder, bowel, and sexual function. This observation mirrors long-term outcome studies that emphasize the importance of structured postoperative rehabilitation and prolonged follow-up [15].

The role of surgical timing remains debated. Meta-analyses have suggested that decompression within 24 hours significantly reduces the risk of abnormal urinary function, while surgery within 48 hours lowers the likelihood of long-term catheterization [16]. However, the recent prospective multicenter UCES study by Woodfield et al. found no consistent association between time to surgery and functional outcomes after adjustment for baseline disability and preoperative catheter status [17].

Finally, CES continues to carry significant medicolegal implications. Delays in presentation, imaging, or operative intervention are frequently cited in litigation, underscoring the necessity for streamlined diagnostic pathways, rapid MRI access, and early surgical decompression [18].

CONCLUSION

Cauda equina syndrome remains a neurosurgical emergency where outcomes are principally determined by preoperative neurological status and surgical timing. Our findings confirm that patients with incomplete CES achieve superior recovery when decompressed within 48 hours, whereas CES-R patients demonstrate poorer outcomes regardless of timing. Despite timely intervention, significant residual bladder, bowel, and sexual dysfunction persists, underscoring the importance of long-term follow-up and rehabilitation strategies. Streamlined diagnostic pathways and rapid access to MRI are essential to minimize delays and improve patient outcomes.

Limitations

Limitations of this study include the single-center design and relatively small sample size, which may reduce generalizability. Additionally, follow-up was limited to one year, potentially underestimating very long-term functional outcomes. Referral bias may also exist, as patients presenting later in the course of disease could have been underrepresented. Future multicenter studies with longer follow-up are warranted to validate these findings.

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