

Acute Cauda Equina Syndrome in Rapid Succession: A Case Series of Eight Consecutive Patients Undergoing Emergency Surgical Decompression Over One Week

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Learning Point of the Article:

Acute cauda equina syndrome requires immediate recognition, urgent MRI, and early surgical decompression. Pre-operative neurological status strongly influences recovery, while timely intervention improves long-term functional outcomes.

Abstract

Introduction: Cauda equina syndrome (CES) is a rare but devastating spinal surgical emergency, most commonly caused by lumbar disc herniation. Delayed diagnosis or decompression may result in irreversible neurological and sphincter dysfunction.

Materials and Methods: This retrospective single-Center case series included eight consecutive patients with acute CES who underwent emergency surgical decompression over 1 week at a tertiary spine care center. Clinical presentation, radiological findings, surgical management, and 6-month post-operative outcomes were evaluated.

Results: The cohort included six males and two females (mean age: 43.1 ± 9.8 years). Urinary dysfunction was present in all patients; five (62.5%) had CES with retention (CESR) and three (37.5%) had incomplete CES (CESI). Saddle anesthesia and motor weakness were observed in 75% and 62.5% of patients, respectively. L4-L5 was the most commonly involved level. Five patients underwent transforaminal lumbar interbody fusion and three underwent decompression with microdiscectomy. The mean interval from bladder symptom onset to surgery was 26.8 ± 11.4 h. At 6 months, complete neurological and sphincter recovery was achieved in five patients (62.5%), partial recovery in two (25%), and persistent bowel/bladder dysfunction in one (12.5%). Patients with CESI demonstrated better recovery than those with CESR.

Conclusion: Early recognition, urgent magnetic resonance imaging, and timely surgical decompression are essential for optimizing neurological and bladder recovery in acute CES. Better recovery was observed among patients presenting with CESI than among those with established urinary retention. These findings reinforce the importance of prompt recognition, urgent diagnostic evaluation, and emergency surgical management before further neurological deterioration.

Keywords: Cauda equina syndrome, lumbar disc herniation, emergency spinal surgery, magnetic resonance imaging, transforaminal lumbar interbody fusion, microdiscectomy, neurological recovery, bladder dysfunction.

Introduction

Cauda equina syndrome (CES) is an uncommon yet devastating spinal surgical emergency caused by compression of the lumbosacral nerve roots distal to the conus medullaris, resulting

in varying degrees of motor, sensory, sphincter, and sexual dysfunction [1]. The reported incidence of CES ranges between 1 in 33,000 and 1 in 100,000 individuals, representing approximately 2–6% of lumbar disc surgeries and nearly 0.04% of

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patients presenting with low back pain [2,3]. Lumbar disc herniation remains the most common etiology, particularly large central lumbar disc prolapses at the L4-L5 and L5-S1 levels, although lumbar canal stenosis, trauma, epidural hematoma, neoplasms, infections, inflammatory conditions, and post-operative complications have also been described as causative factors [4,5].

Clinically, CES encompasses a spectrum of neurological impairment characterized by low back pain, bilateral or unilateral radiculopathy, saddle anesthesia, lower extremity weakness, diminished reflexes, and autonomic dysfunction involving bladder, bowel, and sexual function [6]. Among these manifestations, bladder dysfunction is considered the hallmark feature and an important prognostic indicator [5,6,7]. However, the diagnosis of CES remains challenging because symptoms may be incomplete, asymmetrical, or evolve progressively over time. In an attempt to standardised terminology and increase diagnostic accuracy, Lavy et al. proposed a practical classification system categorizing CES into suspected CES (CESS), incomplete CES (CESI), and CES with retention (CESR), emphasizing the continuum of neurological compromise [8].

Urgent surgical decompression continues to be the cornerstone of management in CES, with the primary aim of preventing irreversible neurological injury and enhancing long-term functional recovery [9,10]. Nevertheless, the optimal timing of decompression is still debated. Several studies have shown better bladder and neurological outcomes when decompression is performed within 24–48 h of symptom onset, whereas other authors have suggested that pre-operative neurological status and severity of bladder dysfunction may exert a greater influence on post-operative recovery than timing alone.

Because of its low incidence, most literature on CES consists of retrospective studies and isolated case reports, with insufficient data on consecutive clustered presentations over a short period. Multiple acute CES presentations requiring emergency surgical decompression within 1 week are unusual and rarely documented. In this case series, we present eight consecutive patients diagnosed with acute CES over 1 week at a tertiary spine care center. We aim to evaluate their clinical presentation, radiological findings, timing of surgery, operative management, and early post-operative neurological and bladder outcomes.

Materials and Methods

Study design and patient selection

This retrospective, single-center case series included eight consecutive patients presenting with acute CES who

underwent emergency surgical decompression at a tertiary spine referral center over 1 week. Clinical records, radiological imaging, operative details, and follow-up data were reviewed from prospectively maintained institutional databases. The consecutive nature of case ascertainment was intended to minimize selective inclusion within the defined study period.

The diagnosis of CES was established based on characteristic clinical features, supported by magnetic resonance imaging (MRI) evidence of significant compression of the cauda equina nerve roots. Clinical features included varying combinations of severe low back pain, unilateral or bilateral radiculopathy, saddle anesthesia, lower extremity weakness, bladder or bowel dysfunction, reduced perianal sensation, and diminished anal sphincter tone.

Patients with CES secondary to acute lumbar disc herniation and/or degenerative lumbar canal stenosis were included. Patients with CES caused by trauma, infection, neoplasm, inflammatory disorders, post-operative hematoma, or prior lumbar instrumentation were excluded.

Clinical and radiological evaluation

Demographic and clinical parameters including age, sex, symptom duration, bladder dysfunction, bowel involvement, motor deficits, sensory disturbances, saddle anaesthesia, gait abnormalities, and ambulatory status were recorded. Motor power was graded using the Medical Research Council system. Urinary dysfunction was categorized as urinary retention, hesitancy, reduced sensation, overflow incontinence, or catheter dependence. Patients were classified according to the clinical status of bladder function at presentation. CESI was defined as neurogenic urinary dysfunction with preserved voluntary bladder control, including altered urinary sensation, urinary hesitancy, difficulty initiating micturition, or a poor urinary stream. CESR was defined as established neurogenic urinary retention with loss of executive bladder control, with or without overflow incontinence.

All patients underwent pre-operative MRI of the lumbosacral spine. Radiological evaluation included the level and morphology of disc herniation, degree of central canal compromise, thecal sac compression, laterality of neural compression, and associated lumbar canal stenosis.

Surgical procedure

All patients underwent emergency posterior lumbar decompression under general anesthesia following radiological confirmation of CES. Surgical procedures were individualized according to the underlying pathology and pre-operative radiological findings. Decompression with microdiscectomy

was performed for focal disc herniation without radiological instability when adequate neural decompression could be achieved without compromising spinal stability. Instrumented fusion was considered in patients with pre-existing or anticipated post-operative instability, extensive degenerative disease requiring substantial facet resection for adequate decompression, or multilevel pathology requiring stabilization.

Surgical timing was calculated from onset of CES symptoms, bladder dysfunction, and hospital admission to operative intervention. Adequacy of decompression was confirmed intraoperatively by visualizing a freely decompressed thecal sac and nerve roots.

Post-operative assessment

Post-operative management included neurological monitoring, bladder care, early mobilization, and supervised physiotherapy rehabilitation. Clinical outcomes assessed during follow-up included recovery of bladder function, motor improvement, sensory recovery, ambulatory status, and residual neurological deficits. Bladder recovery was defined as restoration of voluntary voiding without catheter dependence.

For the purpose of outcome assessment, complete recovery was defined as restoration of voluntary bladder function without catheter dependence, independent ambulation, and absence of

clinically significant residual neurological deficit. Partial recovery was defined as improvement in bladder, motor, or sensory function with persistence of one or more residual neurological or sphincter symptoms. Persistent dysfunction was defined as ongoing clinically significant bowel or bladder impairment requiring continued medical management or intermittent catheterization at the 6-month follow-up.

Functional disability was assessed using the Oswestry Disability Index (ODI) preoperatively and at the 6-month follow-up. ODI scores were recorded from the clinical assessment database and expressed as mean $\pm$ standard deviation

Statistical analysis

Statistical analysis was descriptive because of the small sample size ($n = 8$). Continuous variables were summarized as mean $\pm$ standard deviation, median, and range, while categorical variables were reported as frequencies and percentages. No inferential or multivariable statistical analysis was performed because the sample size was insufficient for reliable statistical testing.

Results

Eight consecutive patients presenting with acute CES

Table 1: Clinical characteristics, radiological findings, surgical management, and 6-month outcomes of individual patients

Patient	Age/sex	Clinical classification	Neurological findings at presentation	MRI findings	Surgical procedure	Early post-operative improvement	6-month outcome
1	42/M	CES-R	Urinary retention, saddle anesthesia	L4-L5 and L5-S1 protruded disc with left paracentral canal stenosis	L4-S1 TLIF	Improvement in radicular pain and bladder symptoms	Complete neurological and bladder recovery
2	42/F	CES-R	Bladder dysfunction, lower limb weakness	L5-S1 extruded disc with severe central canal stenosis	L5-S1 TLIF	Improvement in motor weakness and urinary function	Complete recovery
3	30/M	CES-R	Urinary retention, motor weakness	L4-L5 protruded disc with right paracentral stenosis	L4-L5 posterior decompression+microdiscectomy	Improvement in motor deficits	Complete recovery
4	29/F	CES-I	Saddle anesthesia, urinary hesitancy	L4-L5 sequestered disc with severe central canal stenosis	L4-L5 TLIF	Resolution of radicular pain and urinary symptoms	Complete recovery
5	47/M	CES-R	Bilateral foot drop, bladder dysfunction	L4-L5 extruded disc with severe canal stenosis and sacralized L5	L4-L5 TLIF	Partial motor improvement	Persistent bowel and bladder incontinence with residual foot drop
6	56/M	CES-I	Saddle anesthesia, sensory deficits	L5-S1 inferiorly migrated disc with severe lumbar canal stenosis	L5-S1 decompression+microdiscectomy	Improvement in sensory deficits and bladder symptoms	Complete recovery
7	45/M	CES-R	Bilateral foot drop, urinary retention	L4-L5 extruded disc with severe canal stenosis and sacralized L5	L4-L5 TLIF	Gradual improvement in motor power and bladder function	Partial neurological and bladder recovery
8	54/M	CES-I	Bladder dysfunction, saddle anesthesia	L5-S1 inferiorly migrated disc with severe lumbar canal stenosis	L5-S1 decompression+microdiscectomy	Improvement in radicular pain and urinary symptoms	Complete recovery

MRI: Magnetic resonance imaging, F: Female, M: Male, CES: Cauda equina syndrome, TLIF: Transforaminal lumbar interbody fusion

Table 2: Baseline demographic and clinical characteristics of patients with acute Cauda Equina syndrome

Category	Variable	Value (%)
Demographic characteristics	Total number of patients	8
	Mean age (years)	43.1±9.8
	Age range (years)	29–56
	Male sex	6 (75)
	Female sex	2 (25)
Clinical presentation	Bladder dysfunction	8 (100)
	Bowel dysfunction	3 (37.5)
	Saddle anaesthesia/perineal sensory loss	6 (75)
	Lower limb motor weakness	5 (62.5)
	Bilateral foot drop	2 (25)
Clinical classification	CES with retention (CES-R)	5 (62.5)
	Incomplete CES (CES-I/CES-C)	3 (37.5)
Timing parameters	Mean bladder symptom-to-surgery interval (hours)	26.8±11.4
	Mean admission-to-surgery interval (hours)	8.6±3.2
CES: Cauda equina syndrome		

underwent emergency surgical decompression during the study period. The cohort included six males (75%) and two females (25%), with a mean age of 43.1 ± 9.8 years (range 29–56). All patients presented with acute low back pain associated with unilateral or bilateral lumbosacral radiculopathy and varying degrees of sphincter dysfunction and neurological compromise.

Clinical presentation

Urinary dysfunction was present in all patients (100%) at presentation and was the predominant symptom necessitating urgent surgical intervention. Clinical manifestations included urinary retention, reduced sensation, hesitancy, overflow incontinence, incomplete bladder emptying, and catheter dependence. Associated bowel dysfunction, including constipation, impaired sensation, or fecal incontinence, was observed in three patients (37.5%).

Based on bladder function at presentation, five patients (62.5%) were classified as having CESR, whereas three patients (37.5%) were classified as having CESI.

Saddle or perineal sensory disturbance was identified in six patients (75%), while objective lower extremity motor

weakness was documented in five patients (62.5%).

Bilateral foot drop was present in two patients (25%) at admission. Reduced anal sphincter tone along with impaired perianal sensation was predominantly observed among patients presenting with CES-R.

The mean duration from onset of bladder dysfunction to surgical decompression was 26.8 ± 11.4 h (range 12–48), while the mean interval from hospital admission to surgery was 8.6 ± 3.2 h. Table 1 & 2.

Radiological findings

Pre-operative MRI demonstrated severe compression of the cauda equina nerve roots in all patients secondary to lumbar disc herniation with severe central canal stenosis.

The L4-L5 level was the most commonly involved segment, affecting five patients (62.5%), followed by L5-S1 involvement in four patients (50%). One patient (12.5%) had contiguous two-level pathology involving both L4-L5 and L5-S1.

Regarding disc morphology, extruded disc herniation was most frequent, observed in 3 patients (37.5%), followed by protruded herniation in 2 (25%), inferiorly migrated fragments in 2 (25%), and sequestered herniation in 1 (12.5%). Severe central canal compromise with near-complete cerebrospinal fluid effacement around the cauda equina roots was observed in all cases. Sacralization of the L5 vertebra was noted in two patients (25%), both presenting with bilateral foot drop and advanced neurological deficits in Table 3.

Operative management

All patients underwent emergency posterior lumbar decompression under general anesthesia following radiological confirmation of CES.

Table 3: Radiological characteristics and surgical procedures

Category	Parameter	Value (%)
Level involved	L4-L5	6 (75)
	L5-S1	5 (62.5)
	Multilevel involvement	1 (12.5)
Type of disc herniation	Protruded disc	2 (25)
	Extruded disc	3 (37.5)
	Sequestered disc	1 (12.5)
	Inferiorly migrated disc	2 (25)
Additional radiological findings	Severe central canal stenosis	8 (100)
	Sacralised L5 vertebra	2 (25)
Surgical procedures	TLIF	5 (62.5)
	Posterior decompression+microdiscectomy	3 (37.5)
TLIF: Transforaminal lumbar interbody fusion		



Table 4: 6-month neurological and functional outcomes following emergency surgical decompression

Outcome parameter	Value (%)
Improvement in radicular pain	8 (100)
Improvement in lower extremity motor deficits	4/5 (80)
Complete neurological and sphincter recovery	5 (62.5)
Partial neurological and bladder recovery	2 (25)
Persistent bowel and bladder dysfunction	1 (12.5)
Residual motor deficit (persistent foot drop)	2 (25)
Perioperative complications	0
Revision surgery	0
Mortality	0

Transforaminal lumbar interbody fusion (TLIF) was performed in 5 patients (62.5%) due to segmental instability, severe degenerative stenosis, multilevel involvement, or anticipated instability after decompression. Posterior midline decompression with microdiscectomy was performed in three patients (37.5%) with focal compressive pathology without radiological instability.

Adequate decompression of the thecal sac and traversing nerve roots was achieved in all patients, confirmed intraoperatively by restoration of dural pulsatility and neural decompression. No intraoperative dural tears, implant complications, wrong-level surgeries, or perioperative neurological deterioration occurred.

Neurological and functional outcomes

All patients demonstrated improvement in radicular pain during the immediate post-operative period. Improvement in lower extremity motor function was observed in 4 of 5 patients (80%) with pre-operative motor deficits.

At 6-month follow-up, complete neurological and sphincter recovery was observed in five patients (62.5%). These patients regained normal voluntary voiding, restoration of urinary sensation, independent ambulation, and near-complete resolution of sensory deficits.

Partial neurological and bladder recovery was observed in two patients (25%). Both demonstrated improvement in lower-limb motor function and bladder symptoms but had residual neurological deficits at the 6-month follow-up, including persistent foot drop. One additional patient with advanced CESR had persistent bowel and bladder dysfunction requiring intermittent catheterization and bowel management and also

had persistent bilateral foot drop.

One patient (12.5%) with advanced CES-R at presentation continued to have persistent bowel and bladder dysfunction requiring intermittent catheterization and bowel management at 6 months despite adequate decompression as shown in Table 4. This patient also had persistent bilateral foot drop with minimal neurological improvement. No post-operative wound infection, cerebrospinal fluid leak, implant failure, revision surgery, or mortality was observed during the follow-up period.

Functional disability also improved over the follow-up period. The mean pre-operative ODI was 78.4 ± 8.6 , which decreased to 24.6 ± 10.2 at the 6-month follow-up, corresponding to a mean improvement of 53.8 ± 12.4 points as illustrated in Table 5.

Discussion

CES is an uncommon but potentially devastating spinal emergency caused by compression of the lumbosacral nerve roots within the lumbar spinal canal. Although lumbar disc herniation is the most frequent cause, CES develops in only about 1–2% of lumbar disc herniations and has a reported incidence of 0.3–1/100,000 population annually [1,4]. Delayed diagnosis or surgical decompression can cause irreversible bladder, bowel, sensory, motor, and sexual dysfunction, playing a major role in long-term disability and medicolegal burden [4,8,11].

This study describes an unusual temporal cluster of eight consecutive patients with acute CES presenting over 1 week at a tertiary spine care center. The compressed timeframe of presentation required rapid diagnostic assessment, coordinated emergency surgical workflow, and individualized operative decision-making.

An important finding in this series was that all patients presented with bladder dysfunction, emphasizing its importance as the cardinal clinical feature of CES. Urinary retention, impaired sensation, hesitancy, and overflow incontinence were the predominant manifestations. Five

Table 5: Oswestry disability index (ODI) outcomes at baseline and 6-month follow-up

ODI/functional outcome parameter	Value (%)
Mean pre-operative ODI	78.4±8.6
Mean ODI at 6-month follow-up	24.6±10.2
Mean improvement in ODI	53.8±12.4
Severe disability/crippled (preoperatively)	8 (100)
Minimal-to-moderate disability (6 months)	5 (62.5)
Persistent severe disability (6 months)	1 (12.5)
Persistent sexual dysfunction	1 (12.5)

patients (62.5%) presented with CES-R, indicating severe neural compromise. Several studies have shown that pre-operative bladder status is among the strongest predictors of long-term outcome in CES [10,11,12]. Patients with CESI generally show better post-operative recovery compared with those with painless urinary retention or established sphincter dysfunction.

In the current study, patients with CESI exhibited earlier and more complete neurological recovery than those presenting with CES-R. Similar findings were reported by Srikantharajah et al., who demonstrated significantly improved bladder outcomes in patients undergoing decompression before progression to urinary retention [5]. Likewise, Seidel et al. observed persistent bladder dysfunction in a substantial proportion of patients despite technically adequate decompression, particularly among those presenting with severe urinary retention pre-operatively [3]. Ahn et al. conducted a meta-analysis of 322 patients and further demonstrated that delayed decompression was associated with significantly worse urinary and neurological outcomes [13].

Motor deficits were identified in 62.5% of patients, while bilateral foot drop was observed in two patients with severe canal compromise and sacralized L5 vertebrae. The coexistence of bilateral motor weakness, saddle anaesthesia, and sphincter dysfunction reflects extensive compression of multiple lumbosacral nerve roots and often indicates advanced disease severity. Previous studies have shown that severe pre-operative neurological deficits correlate with delayed or incomplete post-operative recovery [9,12,13].

MRI remains the gold standard imaging modality in CES because of its ability to delineate the level, morphology, and severity of neural compression [8]. In this series, all patients showed severe central canal stenosis with marked compression of the cauda equina roots. The L4-L5 level was most commonly involved, followed by L5-S1, consistent with literature describing increased biomechanical stress and degenerative changes at these levels [1,2,3,4]. Extruded disc herniation was the most common morphology identified. However, sequestered and inferiorly migrated disc fragments were also encountered. These fragments can produce extensive ventral neural compression over multiple levels, resulting in rapid neurological deterioration [14].

The timing of surgical decompression in CES is still a controversial topic in spine surgery. Multiple studies support urgent decompression, chiefly within 24–48 h of bladder dysfunction onset, to maximise neurological recovery [1,5]. In this study, the mean interval from onset of bladder dysfunction to surgery was 26.8 ± 11.4 h, while the mean admission-to-surgery interval was 8.6 ± 3.2 h. All patients underwent

expedited diagnostic evaluation and emergency surgical decompression after clinical and radiological confirmation of CES. Although favorable neurological and functional outcomes were observed in most patients, the small sample size and absence of a comparison group preclude conclusions regarding the independent effect of surgical timing on recovery.

Qureshi and Sell demonstrated that decompression performed after 48 h was associated with significantly poorer bladder, motor, and sexual outcomes [10]. Similarly, Shapiro reported increased rates of persistent sphincter dysfunction and motor deficits among patients undergoing delayed surgery [15]. Recent systematic reviews and meta-analyses have further emphasised that early decompression significantly improves neurological and bladder recovery, particularly in patients with CESI at presentation [4,12].

In this series, complete neurological and sphincter recovery was achieved in 5 patients (62.5%) at 6-month follow-up, while 2 patients showed partial recovery with residual urinary symptoms and persistent foot drop. One patient with advanced CES-R continued to have persistent bowel and bladder dysfunction requiring intermittent catheterization despite adequate decompression. These findings correspond with previous studies showing persistent long-term bladder dysfunction in about 24–50% of patients after CES decompression [1,3,4]. Kumar et al., in a systematic review of 852 CES patients, reported persistent bladder dysfunction in 43.3% and motor weakness in 38.4% during long-term follow-up, indicating considerable residual morbidity despite surgery [4].

The choice of surgical procedure in CES should be individualized according to the underlying compressive pathology and the stability of the affected spinal segment. Microdiscectomy or decompression alone may be sufficient for focal disc pathology when adequate neural decompression can be achieved without destabilizing the segment. Instrumented fusion may be considered when pre-existing instability is present or when adequate decompression requires extensive bony or facet resection that may compromise post-operative stability. In the present series, TLIF was performed in five patients based on the underlying degenerative pathology and stability considerations, whereas focal decompression with microdiscectomy was performed in three patients with localized compressive pathology. Because of the small sample size and non-comparative design, this series cannot determine whether one surgical strategy is superior to another.

Limitations

This study has several limitations. The small sample size ($n = 8$), retrospective single-center design, and short 1-week

recruitment period limit statistical power and generalizability and introduce potential selection, documentation, and recall bias. The absence of a control group and heterogeneity of surgical procedures preclude assessment of the independent effects of surgical timing or surgical technique on outcomes. The small cohort also prevented adjustment for potential confounders, including baseline neurological severity, comorbidities, symptom duration, and timing of decompression. CES was classified as CESI or CESR according to bladder status; however, symptom onset was based on patient history and clinical documentation and may be imprecise. Bladder recovery was assessed clinically without standardized post-void residual, urodynamic, or validated urinary-function measures, and sexual function was not systematically assessed. Although ODI was evaluated, other validated patient-reported outcomes were not collected. The 6-month follow-up may not capture later recovery. MRI assessment was primarily qualitative without quantitative assessment of canal compromise. Finally, the observed favorable outcomes following early decompression are descriptive and do not establish a causal relationship between surgical timing and recovery.

Conclusion

Acute CES secondary to lumbar degenerative pathology is a

spinal surgical emergency requiring prompt clinical recognition, urgent MRI evaluation, and expedited surgical decompression when significant cauda equina compression is confirmed. In this case series, favorable neurological and functional recovery was observed in most patients, particularly among those presenting with CESI, whereas patients with established urinary retention and severe neurological deficits had less complete recovery.

These findings reinforce the importance of early recognition, expedited diagnostic evaluation, and individualized surgical decompression in the management of acute CES. Although limited by the retrospective design and small sample size, this series provides clinically relevant insight into the presentation and short-term outcomes of CES in contemporary spine practice.

Clinical Message

New-onset bladder dysfunction, particularly when accompanied by saddle sensory disturbance or progressive lower-limb neurological deficits, should prompt urgent evaluation for CES. Rapid MRI assessment and expedited surgical decompression of confirmed compressive pathology are central components of management.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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