BMJ Best Practice

Cauda equina syndrome

Straight to the point of care

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Summary

Cauda equina syndrome (CES) is caused by compression of the lumbosacral nerve roots of the cauda equina. It is a neurosurgical emergency; delays in diagnosis and/or surgical treatment may result in permanent, life-changing motor and sensory disabilities including lower limb paralysis and loss of bladder, bowel, and sexual function.

Almost all patients with CES have sciatica and back pain at presentation. Red-flag features for CES, which may be subtle in the early stages, include: bladder dysfunction (e.g., difficulty starting or stopping urination, impaired sense of urinary flow); altered sensation in the perianal, perineal, or genital ('saddle') areas; bowel dysfunction (e.g., loss of sensation of rectal fullness); motor weakness affecting both legs; sexual dysfunction. Urinary retention or overflow incontinence and faecal incontinence are indicators of late-stage or severe CES.

Emergency magnetic resonance imaging (MRI) is essential in any patient with suspected CES.

If CES is confirmed by the combination of clinical features and MRI findings, emergency surgical decompression must be undertaken as soon as possible. Evidence suggests that loss of function in CES is a continuous process with a poorer outcome the longer the cauda equina nerve roots are compressed.

Definition

Cauda equina syndrome (CES) is caused by compression of the lumbosacral nerve roots that extend below the spinal cord. The most common cause is due to disc prolapse at the L4/5 or L5/S1 level and stenosis of the spinal canal. Less commonly, compression may be due to pathology in a higher disc, or to a tumour, infection, or trauma. Typical symptoms and signs of CES include leg pain and/or back pain, together with one or more of: bladder or bowel dysfunction; altered perianal, perineal, or genital sensation; motor weakness affecting both legs; and sexual dysfunction.

For diagnosis and management of compression associated with malignancy, see Malignant spinal cord compression .

Epidemiology

CES is a rare but serious condition.[6] Estimates of the overall incidence of CES are around 1 to 2 cases per 100,000 population per year.[8] [9] One systematic review reported an incidence for CES of 0.3 to 0.5 per 100,000 per year in asymptomatic community populations, 0.6 per 100,000 per year in an asymptomatic adult population, and 7 per 100,000 per year in an asymptomatic working-age population.[10]

An estimated overall prevalence of CES of between 1 in 30,000 to 1 in 100,000 population has been reported. The point prevalence of CES in patients presenting with low back pain has been estimated as 0.04% to 0.08% in primary care, 0.27% in secondary care, and 0.40% in tertiary care.[9] [10] One systematic review calculated that, of adults with suspected CES in a neurosurgical or spinal unit, 19% of those imaged were found subsequently to have radiological and clinical CES.[10]

Risk factors

Strong

lumbar disc herniation

The most common cause of CES overall. CES has been reported to be associated with 1% to 6% of all cases of lumbar disc herniation requiring surgery.[6]

spinal trauma

Vertebral fracture, disc rupture, or extra-axial haematoma due to trauma may result in CES.[2] This is usually within 24 hours of trauma.

spinal surgery

Injury to the cauda equina can occur either during spinal surgery (from direct damage to the nerves) or postoperatively (due to haematoma). CES usually develops within 24 hours of surgery, but may not become apparent until later.[6]

spinal epidural abscess

Characterised by inflammation with accumulation of pus within the epidural space, which may compress the thecal sac and press on the cauda equina. Risk factors for spinal epidural abscess include diabetes mellitus, intravenous drug use, spinal trauma or surgery, indwelling spinal catheter, local or systemic infection, and immunosuppression (e.g., due to long-term systemic corticosteroid therapy).[12]

anticoagulation therapy

Anticoagulation therapy increases the risk of haematoma, particularly after neuraxial anaesthesia or spinal surgery.[6]

Weak

spinal stenosis

The most common cause of thecal sac compression in older people. The progress of spinal stenosis is slow, and symptomatic CES affects only a relatively small number of patients with this condition.[2]

However, asymptomatic spinal stenosis is a common incidental finding in older people and in most cases is not of clinical significance.[13]

spinal tumour

A primary or (more commonly) metastatic spinal cord tumour below the first lumbar vertebra may compress the thecal sac and press on the cauda equina.[2] Typically, symptoms are of insidious onset, although this is not always the case (e.g., sudden vertebral body collapse due to weakening of bone by the tumour).

aged under 50 years

Low back pain with other symptoms in a patient under 50 years is more likely to be indicative of acute CES than in older patients.[14]

Aetiology

CES is caused by a large space-occupying lesion within the canal of the lumbosacral spine. This is most commonly due to disc herniation, usually at the L4/5 or L5/S1 level. Other causes include spinal stenosis (the most common cause of thecal sac compression in older people), traumatic injury, spinal tumour (metastatic or primary), spinal epidural haematoma, and spinal epidural abscess.[6]

Spinal surgery is a risk factor for CES as injury may occur during the surgery itself, or postoperatively due to haematoma. Patients on anticoagulation therapy are at higher risk of haematoma, particularly after neuraxial anaesthesia or surgery.[6]

Pathophysiology

The cauda equina comprises a bundle of spinal nerves (L1 to S5) in a common dural sac that begins at the end of the spinal cord (the spinal cord normally terminates between T12 and L2, most commonly at L1).[6] These nerves are involved in bladder, bowel, lower limb muscle, and sexual function. In CES, the nerve roots are compressed within the lumbosacral spinal canal, resulting in a variety of symptoms. However, not all symptoms are observed in all patients.[6] [8] [11]

Classification

CES can be classified as follows:[1] [2] [3] [4]

- Incomplete CES (CESI): thecal sac compression with subjective symptoms (e.g., difficulty urinating or a loss of desire to urinate, but no retention) and objective signs of CES.
- CES with retention (CESR): thecal sac compression with established neurogenic urinary retention and overflow incontinence.
- Complete CES (CESC): complete loss of all cauda equina function, absent perineal and perianal sensation, and a patulous anus.

However, evidence suggests that classifying individual patients into these subcategories is unreliable, with poor inter-observer agreement between clinicians.[5] Caution is therefore required in clinical practice.

Case history

Case history #1

A 44-year-old man presents with low back pain that has become worse over the past few days. He reports having difficulty when trying to urinate, and erectile dysfunction of recent onset. Bladder palpation indicates urinary retention. Magnetic resonance imaging (MRI) of the lumbar spine reveals a herniated disc that is compressing the spinal nerve roots.

Case history #2

A 23-year-old woman presents 24 hours after a fall while ice skating. Initially, she was assisted to stand, and reported back pain and right hip pain. She was examined at a local emergency department, with plain film imaging, and discharged. After discharge, the patient began to experience 'trouble' passing urine. The next day, the back pain had increased, she could not void, and she had upper leg pain. She attended a second emergency department, where she reported difficulty lifting her legs (grade 3/5 bilaterally), could not void (post-void residual volume 450 mL), and had numbness in her groin/perineum. MRI revealed a large disc herniation at L4-S1.

Other presentations

Almost all patients with CES have sciatica and/or low back pain at presentation. More specific features of CES include: difficulty starting or stopping urination or impaired sensation of urinary flow; urgency; urinary retention with overflow urinary incontinence; loss of sensation of rectal fullness; faecal incontinence; laxity of the anal sphincter; saddle anaesthesia or paraesthesia; progressive neurological deficits affecting both legs; and sexual dysfunction. However, these clinical features have a limited sensitivity for the diagnosis of CES. A patient with CES may have many of these features or just a few, and onset may be insidious or acute.[6] [7]

Recommendations

Key Recommendations

Suspect cauda equina syndrome (CES) if a patient presents with **leg pain and/or back pain** together with recent onset (<14 days), or deterioration, of any of the following red-flag symptoms:[14] [15] [16] [17] [18]

- **Disturbance of bladder or bowel function**. Sensory changes are particularly significant.
- **Altered sensation** (e.g., numbness or pins and needles) around the perianal, perineal, or genital ('saddle') areas.
- Motor weakness or other neurological deficits affecting **both legs**.
- **Sexual dysfunction**.

If suspected CES presents in the community, make an **immediate referral to hospital**, to be seen within a few hours or sooner if possible.[19] This should be to a hospital that has emergency, round-the-clock provision of magnetic resonance imaging (MRI) if at all possible.[15] [16]

If a patient presents at hospital with suspected CES, arrange an **emergency MRI scan** of the lumbosacral spine; this should be performed as soon as possible and certainly within 4 hours of the request.[15] Perform a **pre- and post-void bladder scan** (but only if this will *not* cause a delay in proceeding to MRI scanning).

- A post-void residual volume (PVR) ≥200 mL makes CES significantly more likely, but PVR <200 mL does *not* exclude it.[15] [20] [21] [22]
- Note that a digital rectal examination is *not* required to meet the index of suspicion to justify emergency MRI.[14] [23]

Confirmation of a CES diagnosis depends on the combination of cauda equina compression detected on MRI together with the presence of one or more red-flag symptoms or signs.[1] [4]

If CES is confirmed, make an immediate referral, day or night, for **emergency spinal decompression surgery**.[15] [16] [17]

Full Recommendations

Clinical presentation

CES is a spinal surgical emergency that must be diagnosed and treated in a time-critical manner to ensure the best possible outcome.[15]

- Recognition of early symptoms and signs is paramount so that treatment can be initiated before CES progresses to cause irreversible damage.[1] [8] [14] This can be challenging as many of the early symptoms and signs may be subtle and non-specific.
- Delays in diagnosis and/or surgical treatment can result in permanent, life-changing motor and sensory disabilities including lower limb paralysis and loss of bladder, bowel, and sexual function.[15] [16] [24] [25]

Suspect CES in any patient who presents with **leg pain and/or back pain** together with recent onset of (<14 days), or deterioration of, any one or more of the following red-flag symptoms:[14] [15] [16] [17] [18]

- **Disturbance of bladder function**: for example, difficulty starting or stopping urinary flow; impaired sensation of urinary flow; urinary retention and/or overflow urinary incontinence (an indicator of late-stage, or severe, potentially irreversible CES).
- **Disturbance of bowel function**: for example, loss of sensation of rectal fullness; changed sensation when passing a bowel movement; loss of anal sphincter tone; faecal incontinence (an indicator of late-stage, potentially irreversible CES).

- **Altered sensation** (e.g., numbness) around the perianal, perineal, or genital (**'saddle'**) areas (S2-S5 dermatomes). This may be subjectively reported by the patient or objectively identified on examination.
- Severe or progressive **neurological deficits affecting both legs:** for example, major motor weakness of foot dorsiflexion, ankle eversion, or knee extension.
- **Sexual dysfunction**: for example, inability to achieve erection or ejaculate, or loss of genital sensation.

It is vital to focus on identifying the early features of CES as this is the group of patients with most to gain from time-critical surgical intervention. Such patients may have only **subtle neurological symptoms and/or signs**.[23]

- It has been argued that true red flags are the symptoms and signs that warn of further, avoidable damage, and that symptoms and signs of late, irreversible CES (e.g., painless urinary retention or faecal incontinence) could be more accurately described as 'white' rather than 'red' flags.[26]

Practical tip

Be aware that CES does not develop according to a predictable pattern, and presentation varies widely between patients.

- Some patients with CES have only one red-flag symptom, whereas others have several.[1] [18]
- Onset of symptoms may be rapid or insidious, and the sequence of symptom onset varies between individuals.[6] [7] [14] [25]

If a patient with symptoms of suspected CES presents in the community, make an **immediate referral to hospital** (to be seen within a few hours or sooner if possible), in line with local pathways.[19]

- Under the NHS England national pathway for CES, the immediate referral should be to a hospital that has emergency (ideally round-the-clock) provision of magnetic resonance imaging (MRI).[15] [16] [NHS England, Getting It Right First Time: national suspected cauda equina interactive pathway]
- If a face-to-face assessment is not possible or will delay referral, make an emergency referral based on identification of CES symptoms during a telephone assessment.[15]
- Do not request any community-based investigations. The priority is immediate referral to a hospital with emergency MRI provision.

If a patient presents in a hospital setting with recent-onset (<14 days) or deteriorating symptoms of CES, arrange **emergency MRI** as soon as possible. Perform a **pre- and post-void bladder scan** (as long as this will not delay the MRI scan).[15]

Confirmation of a CES diagnosis depends on the combination of red-flag symptoms and/or signs together with a positive finding of cauda equina compression on MRI.[1] [4] There is no single symptom or sign (or combination) that reliably confirms or excludes CES, hence emergency MRI is essential in all suspected cases.[1] [9] [27] [28] [29] Conversely, an MRI scan on its own cannot diagnose CES; typical symptoms and/or signs must also be present.[15]

- The reliability of clinical diagnosis is low. Each individual red flag symptom/sign has a low positive predictive value and, at best, only moderate specificity for CES.[14] [15] [16] [18] [24]
- Negative examination findings cannot exclude CES if subjective red-flag symptoms are present.[14] [15] [23] A low threshold is therefore paramount for requesting an emergency MRI for any patient who reports red-flag symptoms, regardless of the absence of relevant signs on examination.[15]

Urgent referral for bilateral sciatica or for stable CES symptoms >14 days' duration

Make an **urgent referral to the musculoskeletal medicine service** (to be seen within 2 weeks) if a patient presents with either of the following:[14] [15]

- Red-flag CES symptoms that have been present for >14 days but are completely stable and non-deteriorating.[15] In this scenario, the urgency of MRI is at the discretion of the specialist clinician.[15]

OR

- Sudden-onset bilateral radicular pain or radicular pain that started unilaterally but has progressed to bilateral **but *without* any red-flag symptoms or signs of CES**. Bilateral radicular pain (i.e., sciatica pain that radiates from the lower back to the buttock and leg) can be a warning symptom that CES may occur.[14] [15] [16] Document the duration, frequency, and progression of the bilateral radicular pain.[15]

Ensure that all such patients are advised to return for immediate re-assessment if any of their symptoms worsen or any new CES symptom develops.[14] If this occurs, emergency referral for an immediate MRI (day or night) is warranted.[1] [15]

- Provide **safety-netting advice**, in patient-appropriate language, highlighting the importance of seeking immediate hospital assessment for possible CES if the patient develops any one or more of the following while waiting for the urgent referral appointment:
  - Loss of feeling or pins and needles affecting the inner thighs or genitals
  - Numbness in or around the back passage or buttocks
  - Altered sensations when using toilet paper
  - Difficulty trying to urinate or trying to stop or control the flow of urine
  - Loss of sensation when passing urine
  - Not knowing whether the bladder is full or empty
  - Inability to stop a bowel movement happening, or leaking of faeces
  - Loss of sensation when passing a bowel motion
  - Loss of genital sensation during sexual intercourse

Practical tip

Warning cards and videos aimed at patients are available for safety-netting. Examples include a video and card (available in multiple languages) produced by the UK Musculoskeletal Association of Chartered Physiotherapists. [NHS/MACP: cauda equina syndrome]

Practical tip

Most patients who have unilateral radicular pain without any red-flag features of CES do not require MRI. The natural history of most cases of nerve root pain is gradual improvement with time.[23]

History

Taking a thorough history is critical to the early diagnosis of CES.[30]

- A cohort study of 621 UK patients with CES found that the most frequent presenting symptoms were back pain (96%), sciatica (93%), bladder dysfunction (83%), and saddle numbness (81%). Bowel dysfunction (39%) and sexual dysfunction (38%) were less commonly reported.[22]

If a patient presents with acute or deteriorating **radicular pain** (i.e., sciatica-type pain that radiates from the lower back to the buttock and leg) and/or **back pain**, assess for the possibility of CES.[14]

- Confirm whether any radicular pain is unilateral or bilateral and stable or progressive.[14]
- Bilateral sciatica on its own is a common presentation in primary care and is not necessarily a trigger to suspect CES.[14] More concerning presentations are sudden-onset bilateral sciatica or unilateral sciatica that progresses to become bilateral; as long as there are no red flags for CES that should trigger emergency magnetic resonance imaging (MRI), these patients require urgent referral (to be seen within 2 weeks) by the musculoskeletal medicine service.[14] [15] However, the evidence base in this area is limited and of poor quality.[14] It is vital to provide safety-netting advice on CES symptoms to any patient who presents with either acute or chronic bilateral sciatica without any red-flag symptoms.[14]

As part of your assessment for possible CES, ask specifically about the following **red-flag symptoms** in any patient who presents with sciatica or low back pain:[14] [15]

- Any changes in **perianal, perineal, or genital sensation**.
- Any change in **bladder or bowel function**, however minor.[1] In particular, check for any difficulty initiating a flow of urine, impaired sensation of urinary flow or bladder fullness, or loss of sensation of rectal fullness. Note that urinary or faecal incontinence are symptoms of late-stage or severe CES and associated with a worse prognosis.[4]
- Any **leg weakness or numbness** or change in mobility.[6] [8]
- Any changes in **sexual function** or sensation. Estimates of the prevalence of sexual dysfunction vary; this is partly because it is often poorly documented.[31] [32]

Practical tip

When patients have acute leg pain and/or back pain, they often emphasise this and overlook subtle symptoms of CES such as perineal numbness or early bladder symptoms (e.g., mild changes in urinary sensation, flow, and/or frequency).[4] [25]

- It is therefore vital to ask very specific, direct questions about the presence or absence of each red-flag symptom, using language the patient understands.
- Explain why you are asking these questions as patients are usually not aware of the possible link between back pain and urinary or bowel symptoms.

Practical tip

Urinary dysfunction is very common in older people, making it challenging to distinguish possible CES from other age-related symptoms. Impaired sensation is a strong pointer to consider the possibility of CES. Good discriminatory questions to ask the patient are:

- Do you know when you need to pass urine?
- Can you stop and start the flow of urine without trouble?
- Does it feel normal when you pass urine?

Practical tip

Low back pain with sexual dysfunction as the only other feature is unlikely to be due to CES.[15]

Document the time of onset of each symptom as this may influence the urgency for MRI and the prognosis following spinal surgery.[14] [15]

- Also record the duration, frequency, and progression of any relevant symptoms.[14]

Be aware of common causes of, and risk factors for, CES:

- The most common **cause of CES** is a large lumbar disc prolapse that compresses the roots of the cauda equina in the lower lumbar spinal canal.[4]
- Rarer causes include haematoma, spinal trauma, recent spinal surgery, spinal epidural abscess, and spinal or epidural anaesthetic.[2] [6] [12] [15] For information on malignant causes, see Malignant spinal cord compression .
- **Risk factors for CES** include age <50 years; anticoagulation therapy (which increases the risk of haematoma); and known spinal stenosis (the most common cause of thecal sac compression in older people).[6] [14]

Note that CES can occur in patients with long-standing conditions such as lumbar canal stenosis.[7] [33] [34]

- In such patients, it is important to ensure that appropriate attention is paid to any new red-flag symptoms, however subtle, that raise suspicion of CES.
- The same criteria can be used as for other patient groups to determine the urgency of referral for imaging.

Physical examination

If CES is suspected in a patient presenting in the community or in hospital, conduct a careful neurological examination with a focus on the **legs**. Assess:[1] [15][23][25]

- **Reflex changes** (ankle, knee, plantar). There may be diminished reflexes depending on the nerve root affected. Bilateral loss of a reflex may indicate compression of nerve roots on both sides.[35]
- Tone and presence or absence of **clonus**.
- For any lower limb **myotomal weakness**.
- For any **numbness or sensory loss** to soft touch or pinprick.
- **Provocative tests** (straight leg raise and femoral nerve stretch test).
- For any changes in **gait**.

Also assess for any soft touch or pinprick sensory loss in the **perianal, perineal, and genital areas** and the posterior thigh.[1][4] [14]

- If this is not carried out, document the reason (e.g., no chaperone available).[14]
- A cohort study of 621 UK patients with CES found that light-touch saddle sensory examination was normal in 33%, unilaterally abnormal in 32%, and bilaterally abnormal in 37%.[22] Pinprick sensation was normal in 33%, unilaterally abnormal in 35%, and bilaterally abnormal in 32%.

> **Practical tip**
>
> The area affected by sensory loss may be small or as large as a horse's saddle (so-called 'saddle anaesthesia').[14] [15]

Palpation may reveal a **full bladder** due to urinary retention, which is a sign of late-stage CES.

A **digital rectal examination (DRE)** is *not* necessary for a community-based presentation of suspected CES.[15]

- It is important, however, to document the patient's subjective assessment of perianal sensation.

In the hospital setting, a DRE can be considered for assessment of anal tone and presence of voluntary anal contraction, but it is *not* essential.[14]

- The value of DRE in the acute diagnosis of CES has been questioned, and it is not required to meet the index of suspicion that justifies an emergency request for magnetic resonance imaging (MRI).[14] [23]
- A meta-analysis of six studies involving 741 patients found that the use of DRE had low diagnostic accuracy for detecting CES but did carry a high risk of false reassurance.[36] DRE also has poor inter-observer reliability.[1]

Remember that a **normal physical examination** does *not* obviate the need for **emergency MRI** if the patient has red-flag symptoms for CES.[14] [15] [23]

Hospital-based investigations

Imaging

Emergency imaging is vital for any patient with suspected CES, to ensure minimal delay if decompression surgery is needed. Magnetic resonance imaging (MRI) is the recommended modality for almost all patients, with computed tomography (CT) reserved for individuals with contraindications to MRI.[1] [15] [16] [17]

- MRI is the preferred imaging investigation because of its ability to accurately depict soft-tissue pathology, assess vertebral marrow, and assess the spinal canal patency.[1] [37]

MRI scanning

Arrange an **emergency MRI** of the lumbosacral spine as the first-line investigation for any patient who presents at or is referred to hospital with red-flag symptoms for suspected CES.[1] [6] [15][16] [18] [24][37]

- Under the NHS England national pathway for suspected CES:[15]
    - MRI should be performed as soon as possible and certainly **within 4 hours** of the request.[15] [18]
    - There is no requirement to discuss the patient with the spinal surgery service prior to the MRI as this may lead to unwarranted delay.[15] [16] However, a discussion with a senior decision-maker (ST4 or equivalent or above) is recommended.[15]
    - If a radiologist is unavailable to report on the scan out of hours, the on-call surgical team can be asked to review it to avoid delay.[15] The UK Royal College of Radiologists' service standards for CES state that the MRI report should be issued within 1 hour of the scan.[18]

A single sagittal T2 weighted sequence is the recommended MRI protocol to screen for cauda equina (CE) compression.[15] [18]

- If CE compression is identified, additional sequences (axial T2 weighted and sagittal T1 weighted) may be needed to inform the surgical approach.[15] [18]

MRI can be used for **pregnant patients** with suspected CES as long as a critical risk-benefit analysis justifies it, and national safety guidelines are followed to minimise risk to the patient and fetus.[18] [38]

The majority of MRI scans for individuals with red flag symptoms and signs are **negative** for CE compression.[17] It is advisable to make the patient aware of this before they have the scan, as this can help to manage expectations around the likelihood of identifying a specific cause for their symptoms.

- One literature review found that rates of positive MRI findings in patients with suspected CES range from 14% to 33%.[1] This is because red-flag symptoms and signs have low specificity for CES and symptoms such as back pain and urinary dysfunction are very common in the general population.[1] [22] [24] No symptom or sign can reliably diagnose or exclude CES prior to the stage where the lesion is severe and the neurological damage is irreversible.[17] It is therefore vital to

maintain a low threshold for requesting emergency scanning despite the low likelihood that it will confirm the diagnosis.[17] [25]
- Conversely, **positive** MRI findings must always be interpreted in the context of the full clinical picture. If there is a discrepancy between the physical examination or symptoms versus MRI findings, it is important to remember that the sensitivity of MRI in relation to CES means that it is used to 'rule in' rather than 'rule out' the diagnosis.

Computed tomography (CT)

If there is an absolute **contraindication to MRI** (e.g., presence of an MR-unsafe implant), request a CT scan or CT myelogram.[15] [18] It may be appropriate to consult the spinal surgery team in these circumstances.[16]

- CT can delineate whether CE compression is present but is less precise than MRI at characterising the aetiology of CES.[37] Thecal sac effacement of ≥50% has been proposed as a criterion for identifying CES on CT.[39]
- CT modalities have poor soft-tissue contrast compared with MRI and so might not reveal disc protrusions in older patients with degenerative spinal conditions.[18]
- CT myelography can be used to assess the patency of the spinal canal/thecal sac, and can be useful for surgical planning.[37]

Pre- and post-void bladder scan

A pre- and post-void bladder scan can be a useful adjunct to MRI in assessment of **urinary retention** and completeness of bladder emptying in a patient with suspected CES.[15] [40] It can be undertaken while the patient is waiting for MRI scanning but it **must not delay MRI scanning** or surgery.[15]

- Do not use the results of bladder scanning in isolation to determine whether an MRI is indicated.[15] Every patient with suspected CES requires an emergency MRI, regardless of the findings of a bladder scan.[15] [22]

If the patient is able to void, document the pre-void volume and the post-void residual volume (PVR).[15]

- **PVR ≥200 mL** makes CES significantly more likely.[15] A prospective study of 260 patients with suspected CES found that a PVR ≥200 mL had 94% sensitivity and 67% specificity for identifying MRI-positive CES.[20]
- PVR <200 mL makes CES less likely but does *not* exclude it.[15] [21] A multi-centre cohort study of 621 UK adults with CES found that 59% of those who had a bladder scan documented had a PVR <200 mL.[22]
- If PVR is >600 mL, **catheterise** the patient. Perform a catheter tug to check whether the patient has sensation.

Referral for emergency surgery

If imaging confirms cauda equina compression:

- Make an immediate referral (day or night) for **emergency spinal decompression surgery**.[15] [16] [17]
    - If this requires transfer to another hospital, the NHS England national pathway for CES recommends transfer via a category 2 blue-light ambulance.[15]
- Keep the patient nil by mouth in preparation for surgery.[15]

- As soon as a decision to operate has been made, catheterise the patient (if catheter is not already in place).[15]

If there is no CE compression but imaging indicates the presence of neural compression that explains the patient's radicular pain:[15] [16]

- Provide **safety-netting** advice about the importance of seeking immediate help should any symptoms of CES develop.
- Make a referral to the community musculoskeletal medicine team.

Severity of neurological deficit

The extent of the patient's neurological deficit at presentation has a significant impact on the prognosis as it reflects the degree of damage to the cauda equina nerves.[1] [4] [15] It may also be a factor informing the precise urgency of emergency surgery.[23]

- It is important to document the degree of neurological deficit: in particular, whether the patient has **painless urinary retention** and overflow incontinence (which is sometimes referred to as CESR).
- Patients who retain some **executive control over bladder function** (sometimes referred to as incomplete CES or CESI) have a better prognosis than those with painless urinary retention (CESR). Patients with CESI may have altered urinary sensation, a loss of the desire to void, a poor urinary stream, and a need to strain in order to urinate, but voluntary voiding remains possible even if difficult.
- Although the prognosis is less positive for patients with CESR, evidence suggests that a significant proportion of this group will benefit from at least some recovery of bladder function following decompression surgery.[22]
- It is generally agreed that patients who present with complete CES have a poor prognosis for recovery. Complete CES is characterised by loss of all CE function, absent perineal sensation, a paralysed and insensate bladder and bowel, no perineal or perianal sensation, and a patulous anus.[4]

However, classifying individual patients into subcategories of CES severity is unreliable and requires great caution in clinical practice.[5]

- Several groups have proposed that it is important to subcategorise CES patients according to their degree of neurological deficit (for example, suspected CES, early CES, incomplete CES, CES with painless urinary retention, or complete CES).[1]
- However, research shows that there is very poor inter-observer agreement between clinicians when asked to determine the most appropriate subcategory of CES for 100 individual patient vignettes.[5]

DIAGNOSIS

History and exam

Key diagnostic factors

bladder dysfunction (common)

Bladder dysfunction is a red-flag symptom for CES in any patient who presents with leg pain and/or back pain. If symptoms are of recent onset (<14 days) or deteriorating, this warrants immediate referral for emergency MRI scanning.[14] [15] [16] [17] [18]

- A cohort study of 621 UK patients with CES found that 83% had bladder dysfunction symptoms at presentation.[22]

Early signs of dysfunction may be subtle and include: reduced awareness of full bladder; loss of urge to urinate; urgency; difficulty in starting or stopping the urine stream; reduced awareness that urination is occurring; recent-onset or progressively worsening weak urine stream.[8]

Urinary incontinence is due to overflow from retention and is an indicator of late-stage, potentially irreversible CES. Palpation may reveal a full bladder due to urinary retention.

Practical tip

When patients have acute back and/or leg pain, they often emphasise this and overlook subtle symptoms of CES such as early bladder symptoms (e.g., mild changes in urinary sensation, flow, and/or frequency).[4] [25]

- It is therefore vital to ask very specific, direct questions. Explain why you are asking these questions as patients are usually not aware of the possible link between back pain and urinary symptoms.

Practical tip

Urinary dysfunction is very common in older people, making it challenging to distinguish possible CES from other age-related symptoms. Impaired sensation is a strong pointer to consider the possibility of CES. Good discriminatory questions to ask the patient are:

- Do you know when you need to pass urine?
- Can you stop and start the flow of urine without trouble?
- Does it feel normal when you pass urine?

saddle paraesthesia/anaesthesia (common)

A change in perianal, perineal, or genital sensation is a red-flag symptom for CES in any patient who presents with leg and/or back pain. If symptoms are of recent onset (<14 days) or deteriorating, this warrants immediate referral for emergency MRI scanning.[14] [15] [16] [17] [18]

- A cohort study of 621 UK patients with CES found that 81% reported saddle numbness at presentation.[22]

Altered sensation of these 'saddle' areas (S2-S5 dermatomes) may be subjectively reported by the patient or objectively tested on examination. The affected area may be small or as large as a horse's saddle.[14] [15]

Practical tip

When patients have acute back and/or leg pain, they often emphasise this and overlook subtle symptoms of CES such as perineal numbness.[4] [25]

- It is vital to ask specific, direct questions about the presence or absence of each red-flag symptom. For example, if a patient presents with low back pain and sciatica, ask if they have any 'pins and needles' around their back passage, buttocks, or genitals.

lower limb weakness (common)

A severe or progressive neurological deficit affecting both legs (e.g., major motor weakness of foot dorsiflexion, ankle eversion, or knee extension) is a red-flag symptom for CES in any patient who presents with back and/or leg pain. If symptoms are of recent onset (<14 days) or deteriorating, this warrants immediate referral for emergency MRI scanning.[14] [15] [16] [17] [18]

diminished or absent lower limb reflexes (common)

Assess for any reflex changes (ankle, knee, plantar). There may be diminished reflexes, depending on the nerve root affected.

bowel dysfunction (uncommon)

Bowel dysfunction is a red-flag symptom for CES in any patient who presents with leg and/or back pain. If symptoms are of recent onset (<14 days) or deteriorating, this warrants immediate referral for emergency MRI scanning.[14] [15] [16] [17] [18]

- A cohort study of 621 UK patients with CES found that 39% had bowel dysfunction at presentation.[22]

Symptoms and signs include loss of sensation of rectal fullness, changed sensation when passing a bowel movement, and laxity of the anal sphincter. Faecal incontinence is an indicator of late-stage CES.

A digital rectal examination (DRE) is *not* necessary for a community-based presentation of suspected CES.[15] It is important, however, to document the patient's subjective assessment of perianal sensation. In the hospital setting, a DRE can be considered for assessment of anal tone and presence of voluntary anal contraction but is not essential.

- The value of DRE in the acute diagnosis of CES has been questioned, and it is not required to meet the index of suspicion that justifies an emergency request for MRI.[14]

Other diagnostic factors

sciatica (radicular pain) (common)

Sciatica (i.e., pain that radiates from the lower back to the buttock and leg) is a typical but non-specific presenting symptom of CES.[14] [15] [16]

- A cohort study of 621 UK patients with CES found that sciatica was recorded in 93% of patients at presentation.[22]

If a patient presents with sciatica together with recent onset (<14 days) of, or deterioration of, any one or more of the following CES red-flag symptoms, an immediate referral for emergency MRI is warranted:[14] [15] [16] [17][18]

- Disturbance of bladder function
- Disturbance of bowel function
- Altered sensation around the perianal, perineal, or genital ('saddle') areas, either subjectively reported or objectively observed

- Severe or progressive neurological deficits affecting both legs
- Sexual dysfunction

If a patient has bilateral sciatica but without any red-flag symptoms or signs for CES, UK guidelines recommend an urgent referral to the musculoskeletal medicine service (to be seen within 2 weeks). [14] [15] [16]

- Ensure that all such patients are given safety-netting information advising them to return for immediate re-assessment if any of their symptoms worsen or any new CES symptom develops.[14] If this occurs, emergency referral for an immediate MRI (day or night) is warranted.[1] [15]

low back pain (common)

Back pain is a typical but non-specific presenting symptom of CES.[14] [15] [16]

- A cohort study of 621 UK patients with CES found that 97% had back pain at presentation, making it the most frequently reported symptom.[22]

If a patient presents with back pain together with recent onset (<14 days) of, or deterioration of, any one or more of the following CES red-flag symptoms, an immediate referral for emergency MRI is warranted:[14] [15] [16] [17][18]

- Disturbance of bladder function
- Disturbance of bowel function
- Altered sensation around the perianal, perineal, or genital ('saddle') areas, either subjectively reported or objectively observed
- Severe or progressive neurological deficits affecting both legs

sexual dysfunction (uncommon)

Sexual dysfunction is a red-flag symptom for CES in any patient who presents with sciatica. If symptoms are of recent onset (<14 days) or deteriorating, this warrants immediate referral for emergency MRI scanning.[14] [15][16] [17] [18]

- Estimates of the prevalence of sexual dysfunction vary; this is partly because it is often poorly documented.[31] [32] A cohort study of 621 UK patients with CES found that sexual dysfunction was recorded as a presenting symptom for 38%.[22]

Symptoms and signs include reduced sensation, erectile dysfunction, and reduced ability to achieve orgasm.[6]

> **Practical tip**
>
> Low back pain with sexual dysfunction as the only other feature is unlikely to be due to CES.[15]

Investigations

1st test to order

Test	Result
MRI lumbar spine without intravenous contrast Arrange an emergency MRI of the lumbosacral spine as the first-line investigation for any patient who presents at or is referred to hospital with red-flag symptoms for suspected CES.[1] [6] [15][16] [18] [24] [37] • Under the NHS England national pathway for suspected CES, MRI should be performed as soon as possible and certainly within 4 hours of the request.[15] [18] MRI is the preferred imaging investigation in the evaluation of suspected CES because of its ability to accurately depict soft-tissue pathology, assess vertebral marrow, and assess the spinal canal patency.[1] [37] A single sagittal T2 weighted sequence is the recommended MRI protocol to screen for cauda equina (CE) compression.[15] [18] If CE compression is identified, additional sequences (axial T2 weighted and sagittal T1 weighted) may be needed to inform surgery.[15] [18] If imaging confirms CE compression, make an immediate referral (day or night) for emergency spinal decompression surgery.[15] [16] [17]	visualisation of lesion and compression of cauda equina
CT lumbar spine without intravenous contrast If there is an absolute contraindication to MRI (e.g., presence of an MR-unsafe implant), request a CT scan or CT myelogram.[15] [18] CT can delineate whether cauda equina (CE) compression is present but is less precise than MRI at characterising the aetiology of CES.[37] If imaging confirms CE compression, make an immediate referral (day or night) for emergency spinal decompression surgery.[15] [16] [17]	visualisation of lesion and compression of neural structures thecal sac effacement of ≥50% has been proposed as a criterion for identifying CES on CT[39]
bladder scan (pre- and post-void) A pre- and post-void scan of the bladder can be a useful adjunct to MRI in assessment of urinary retention and completeness of bladder emptying in a patient with suspected CES.[15] [40] It can be undertaken while the patient is waiting for MRI scanning but it must not delay MRI scanning or surgery.[15] • Do not use the results of bladder ultrasound in isolation to determine whether an MRI is indicated.[15] Every patient with suspected CES requires an emergency MRI, regardless of the findings of a bladder scan.[15] [22] If the patient is able to void, document the pre-void volume and the post-void residual volume (PVR).[15]	PVR ≥200 mL makes CES significantly more likely; PVR <200 mL makes CES less likely but does *not* exclude it[15] [21] may indicate urinary retention if patient has late-stage CES

Other tests to consider

Test	Result
CT myelography of the lumbar spine Assesses the patency of the spinal canal/thecal sac, and the subarticular recesses and neural foramen. It can be useful for surgical planning in patients with CES.[37] Lumbar puncture in the lower segments may exacerbate CES.	shows degree of cord compression

Differentials

Condition	Differentiating signs / symptoms	Differentiating tests
Spinal epidural abscess	• Fever is often present. • Potential risk factors include a history of intravenous drug use, diabetes mellitus, history of recent spinal surgery or trauma, indwelling spinal catheter, contiguous local infection, concomitant bacteraemia or endocarditis, chronic renal disease, and immunosuppression (e.g., HIV infection, malignancy).	• Gadolinium-enhanced MRI spine shows epidural space and bone involvement of abscess. • Blood or cerebrospinal fluid culture will be positive for causative organism - most commonly *Staphylococcus aureus* , although many other bacteria have been implicated. FBC, CRP, and ESR are usually elevated.
Malignant spinal cord compression (MSCC)	• Pre-existing cancer diagnosis and/or systemic signs of malignant disease (e.g., unexplained weight loss).[23] • Prostate, lung, breast, renal, and thyroid cancers have been particularly associated with MSCC, but any systemic cancer can metastasise to the spine.[41]	• MRI shows spinal neoplasm.
Multiple sclerosis	• Common symptoms include visual disturbance in one eye (e.g., greying or blurring); fatigue; poor balance.	• MRI typically shows demyelinating lesions in the spinal cord. • Brain MRI typically shows demyelination perpendicular to the lateral ventricles and corpus callosum. • Cerebrospinal fluid analysis may show oligoclonal bands.
Transverse myelitis	• Various aetiologies, including post-infectious, autoimmune, and inflammatory. • More than half of patients have a systemic viral illness 1-4 weeks before onset of neurological symptoms. Most have leg weakness of varying degrees of severity. The arms are involved in a minority of cases.	• MRI shows focal demyelination with possible enhancement at the appropriate level, and excludes compressive lesion. • Cerebrospinal fluid analysis shows pleocytosis with a modest number of lymphocytes and increase in total protein.
Degenerative myelopathy (cervical/thoracic)	• Presents with progressive neurological symptoms, often including loss of balance and upper body symptoms (e.g., loss of hand	• MRI shows cervical or thoracic stenosis with or without cord signal change. Confirmation of the diagnosis requires both

Condition	Differentiating signs / symptoms	Differentiating tests
	or digit dexterity; loss of fine motor control); brisk reflexes (as opposed to diminished or absent reflexes, which may be seen in CES). May have upper limb radicular pain.[42] [43]	typical clinical features and positive radiological findings.
Traumatic conus medullaris (CMS)	• Patients with axial compression injury (e.g., fall, motor vehicle accident) or flexion injury can experience a vertebral body fracture with retropulsion of a fragment of bone or disc, and spinal shock. This usually resolves in a few days. Penetrating injuries (e.g., projectile, knife) often cause loss of function and, with entry forces, conus medullaris syndrome or CES-like symptoms.	• A history of the injury and some description of the force vectors (if known) leads to the diagnosis. Imaging includes MRI without contrast and/or CT scanning. CMS may result from injury of vertebrae T12 to L2, and involves damage to neural structures from spinal cord segment T12 to nerve root S5; CES may result from an injury of vertebrae L3 to L5, and involves damage to nerve roots L3 to S5.[44]
Benign prostatic hypertrophy	• Urinary symptoms not accompanied by any change in sensation. • Absence of sciatica or back pain. • Digital rectal examination may detect an enlarged prostate. • Generally presents in older men (age >50 years).	• No findings on spinal MRI. • Typically a clinical diagnosis with negative urinalysis.

Recommendations

Key Recommendations

Cauda equina syndrome (CES) is a **neurosurgical emergency**, and decompression surgery must be performed as soon as possible.[1] [15]

- The primary goal is to alleviate compression of the cauda equina and prevent neurological deterioration, thereby preserving the function that is present at the time of surgery.[1] [22] There is also scope to partially reverse the neurological deficit in some patients.[17]
- Outcomes tend to be worse for patients who have painless urinary retention and overflow incontinence (CESR) than for those who retain some executive control of bladder function (incomplete CES or CESI).[15] [17] However, evidence shows there is hope for some improvement in bladder function following decompression surgery for CESR.[22]

For patients with **CESI**, surgery should be undertaken as an **emergency, day or night**.[15] For patients with **CESR**, for whom the prognosis is less positive, surgery should be undertaken **within 24 hours** of the magnetic resonance imaging (MRI) scan, with the exact timing at the discretion of the surgeon.[15]

- In practice, the decision on timing of surgery can take into account the duration and clinical course of symptoms and signs, along with the potential for increased morbidity when operating at night, particularly given the complexity of the surgery for a large central disc prolapse.[16] [17]

Pain, loss of perineal sensation, and bladder, bowel, and sexual **dysfunction may persist long term** after CES, although many patients do recover significant function.[1] [6] [45]

- Ask about ongoing symptoms after surgery, and refer as needed to the appropriate local service for access to a bowel programme and ongoing management of urinary symptoms, pain, and sexual dysfunction.[15] Psychological support may also be helpful.[15]

Full Recommendations

Decompression surgery

CES is a **neurosurgical emergency**. Patients are treated with decompression surgery, together with appropriate supportive care.[1] [3] [15] The objective is to alleviate compression of the cauda equina, thereby preventing neurological deterioration and possibly reversing some of the neurological deficit.[1] [22]

- **Catheterise** the patient (if catheter is not already in place) as soon as a decision to operate has been made.[15]

Total laminectomy, hemilaminectomy, and laminotomy are all acceptable techniques for decompression surgery.[15] The most appropriate technique is selected based on the patient's pathology and the experience of the surgeon.[6]

All patients undergoing surgery for CES should be advised that the intention is to **preserve the function** that is present at the time of surgery. There is some scope for improvement but also a small risk of making matters worse should complications occur.[17]

- Pain, loss of perineal sensation, and bladder, bowel, and sexual dysfunction may persist, although significant recovery of function is possible.[1] [6] [45]
- Outcomes tend to be worse for patients who have painless urinary retention and overflow incontinence (CESR) than for those who retain some executive control of bladder function (CESI).[15] [17]

Timing of surgery

Decompression surgery must be performed as soon as possible, and the principle that **emergency surgery** is indicated for all patients with CES now has widespread support.[1] [15] However, the **precise timing thresholds** remain a source of debate.[4] [22]

- The British Association of Spine Surgeons (BASS)/Society of British Neurological Surgeons (SBNS) standards of care document for CES states that nothing is to be gained by delaying surgery, whereas there is potentially much to be lost.[16] [17] It recommends that there are no safe time thresholds for surgery and that emergency surgical decompression must take place at the earliest opportunity for all patients with imaging-confirmed CES.[16] [17]
- The NHS England national pathway for CES recommends that the urgency of emergency surgery depends on the degree of neurological symptoms at presentation. For patients with **incomplete symptoms of CES** (CESI), who retain some executive control over bladder function, surgery should be undertaken as an **emergency day or night**, and any reason for delay should be documented; only life-threatening cases should take priority over emergency surgery for incomplete CES.[15] For patients with CES with **painless urinary retention and overflow incontinence** (CESR), for whom the prognosis is less positive, surgery should be undertaken **within 24 hours** of the MRI scan, with the exact timing at the discretion of the surgeon.[15] [NHS England, Getting It Right First Time: national suspected cauda equina interactive pathway]

In practice, the decision on timing of surgery can take into account the duration and clinical course of symptoms and signs, along with the potential for increased morbidity when operating at night, particularly given the complexity of the surgery for a large central disc prolapse.[16] [17]

Evidence: CES severity and timing of surgery

The level of neurological dysfunction at the time of surgery (as opposed to time since symptom onset) appears to be the most significant determinant of prognosis.

A US-based retrospective cohort study of 20,924 individuals with CES reported that patients undergoing surgical decompression on hospital day 0 or 1 had better inpatient outcomes, including lower complication and mortality rates, than patients having surgery on day 2 or later.[46] Delayed surgery was associated with statistically significant increased inpatient mortality (odds ratio [OR] 9.60, P = 0.002), total complications (OR 1.41, P = 0.018), and non-routine discharge (OR 2.37, P <0.0001).[46]

- Other evidence on the benefits of earlier surgery (e.g., within 24 hours) is equivocal.[6] [47] [48] [49] The disparities in evidence may be due to differences in degree of neurological deficit among participants.[50] [51]

It is likely that the level of neurological dysfunction at the time of surgery (rather than time since symptom onset) is the most significant determinant of prognosis.[49] [52]

- The weight of evidence suggests that loss of function in CES is a continuous process with a poorer outcome the longer the cauda equina nerve roots are compressed.[1] [17]
- For a significant minority of patients with CES, an irreversible neurological deficit has already occurred by the time of presentation, but it is not easy to identify which individuals fall into this subset.[18]
- Incomplete CES (CESI) has a better prognosis than CES with painless urinary retention and overflow incontinence (CESR). Nonetheless, evidence suggests that more prolonged compression in patients with CESR can result in additional neurological loss and that a significant proportion of this group (around 70%) will gain some benefit from decompression surgery.[15] [17]
    - A prospective cohort study that followed up 621 UK adults with CES found that postoperative functional improvement occurred in significant numbers of patients who had presented with urinary retention (with or without sensation to the catheter), suggesting a benefit of surgical decompression in reversing neurological deficits among patients with CESR.[22] Some 70% of patients who had required preoperative catheterisation for urinary retention (including 57% of those who had no sensation to the catheter) were no longer using a catheter by discharge. At 1-year follow-up, only 26% of individuals who had required preoperative catheterisation still needed to use a catheter, suggesting a significant potential for recovery of bladder function in patients who present with retention with or without an insensate bladder.[22]
    - The study also found that bladder outcomes and disability at 1-year follow-up were associated with severity at presentation but not with time from symptom onset to surgery, although the authors noted that the observational nature of the study limited interpretation of the implications of this finding for recommendations on urgency of surgery.[22]

- A 2016 evidence review concluded that:[1]

- Incomplete CES (CESI) is a true indicator for immediate emergency surgery day or night. This recommendation was based on the finding that the longer the duration of cauda equina compression in patients with CESI, the worse the bladder outcomes (even if surgery was performed prior to deterioration to CESR).[1] One retrospective cohort study of 139 patients with CESI found that the likelihood of a patient ending up with normal bladder function restored was twice as high for those who had surgery within 24 hours compared with those operated on between 24 and 48 hours (OR 1.9, 95% CI 0.5 to 7.5).[51]
- Any patient in the early stage of CESR (<12 hours) or who has CESR with some residual sacral nerve root function should also have emergency surgery day or night. There is a paucity of evidence on the impact of timing of surgery on outcomes for this patient group; some studies do support earlier surgery, but the evidence is conflicting.[1] One small study of 17 patients with CESR showed benefit from surgery within 12 hours.[48]
- Any patient who has either prolonged CESR with no residual nerve root function or complete loss of all cauda equina function (with absent perineal and perianal sensation, a paralysed and insensate bladder and bowel, and a patulous anus) can have surgery the following day.[1]

Surgical complications

Complication rates in decompression surgery are around **six times higher** for patients with CES than for those who have similar surgery for other indications.[15]

- To avoid bladder distension injury, the patient should be catheterised before surgery begins.[15]
- A cohort study of 621 UK patients with CES reported that complications occurred in 26% of individuals, with the most common being durotomy or cerebrospinal fluid (CSF) leak (12%) and postoperative neurological deterioration (12%).[22]

Postoperative care

Encourage the patient to **mobilise** as soon as possible after surgery (usually starting on the day after surgery).[15]

Ensure a full **assessment of motor and sensory function** prior to discharge.[15]

- Any splints or orthotics that are needed should be fitted pre-discharge.[15]

Ask about **bladder, bowel, and sexual function** and pain. Refer any patient who has ongoing symptoms after surgery for CES to a rehabilitation unit. In the UK, this would typically be a spinal cord injury unit.[15]

Many patients experience **psychological** issues.

- All patients can benefit from being informed about relevant support groups. In the UK, examples include the Cauda Equina Champions Charity and the Spinal Injuries Association.[15] [Cauda Equina Champions Charity] [Spinal Injuries Association]

- Those with ongoing disability should be offered psychological support, according to the local pathway. In the UK, this is typically provided by the spinal cord injury service.[15]

Urinary function

Undertake a **trial without catheter** (TWOC) as soon as feasible postoperatively and obtain pre- and post-void bladder scans.[15]

- If the post-void residual volume (PVR) is <100 mL, the patient can be discharged without a catheter.[15]
- Recatheterisation with a long-term catheter is indicated if the pre-void bladder scan is >500 mL with no sensation to void *OR* the patient has not voided after 6 hours *OR* the PVR is >100 mL.
    - Do not attempt a second TWOC if the first trial has failed.[15]
    - An intermittent catheter is preferred, if feasible, as it is associated with lower rates of urinary tract infection, urethral trauma, and renal complications.[53] [54] [55] [56]
    - If flip/flow catheterisation is used, it must be opened at least once every 4 hours, including overnight, aiming to maintain a bladder volume <500 mL.
- Refer to the appropriate service so that the patient can be taught how to self-catheterise.[15] This may be the continence, urology, or spinal cord injury team; check local protocols.[16]

At surgical outpatient follow-up, check for any ongoing urinary symptoms and refer to the appropriate service if present.[15]

Bowel function

Ensure that all patients treated for CES are provided with advice on the potential for ongoing **neurogenic bowel problems**.[15] These can include involuntary bowel movements, constipation, and impaction.[57] [58]

- A bowel management plan should be instigated within 24 hours of admission.[58]
- Laxatives and/or bowel evacuation may be necessary.[57] [59] Patients should be taught how to undertake digital rectal stimulation (DRS) followed by digital rectal evacuation (DRE).[15]
- Patients with bowel dysfunction resulting from injury to the cauda equina may have areflexic (flaccid) bowel dysfunction in the short or long term, although mixed reflex and areflexic dysfunction is also possible.[58]
- Referral to a bowel programme may be needed for individualised rehabilitation and ongoing management.[15] [57] [58] [59] This may be provided by the continence, colorectal, or spinal cord injury service; check local protocols.[16]

At surgical outpatient follow-up, check for any ongoing bowel symptoms and refer to the appropriate service if present.[15]

Sexual function

Ensure that all patients are offered advice on the potential for sexual dysfunction following surgery for CES.[15]

- Refer any patient with ongoing sexual dysfunction to the appropriate local service or spinal cord injury service as treatment options are available for both men and women.[15]

Pain management

Patients who present with suspected CES are often in significant pain. Prompt **up-titration of analgesics** may be needed to relieve pain and facilitate effective clinical examination and MRI scanning.[23]

Advise the patient that it is normal to continue to experience some degree of back and leg pain after surgery and that recovery of nerve function can continue for up to **18 months to 2 years**.

- If a patient experiences an unusual degree of pain during this period, it is important to exclude further disc prolapse (with an MRI if appropriate).[15]

During the **first 3 months** following surgery for CES, acute pain management follows the standard analgesic ladder for postoperative care.[15]

- Use of simple analgesia (i.e., paracetamol and/or a non-steroidal anti-inflammatory drug [NSAID] with gastrointestinal [GI] protection) is recommended.[60] Long-term use of NSAIDs can be associated with GI adverse effects (bleeding, perforation, or ulceration), cardiovascular thrombotic events, and renal disease. Use the lowest effective dose for the shortest effective treatment duration.
- Opioids (with adjunct treatments to prevent constipation) should only be used in the very short term postoperatively. They can be considered for individuals with a high functional pain assessment score, with appropriate monitoring and advice on de-escalation of opioid use.[60] Immediate-release formulations of opioids are preferred.[60] Be aware that opioids can exacerbate bowel and bladder dysfunction. Ensure frequent re-assessment of any patient whose level of pain does require a short-term opioid.[60]

For management of **chronic pain** (**>3 months post-surgery** for CES), do *not* offer opioids, gabapentinoids, anticonvulsants, oral corticosteroids, or benzodiazepines.[15]

- Consider lumbar nerve root block with an injection of local anaesthetic/corticosteroid.[15]
- If the patient has persistent neuropathic pain, refer for consideration of spinal cord stimulation.[15] [61]

Treatment algorithm overview

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Acute (summary)		
confirmed CES		
	1st	**decompression surgery**
	plus	**bladder management**
	plus	**bowel management**
	plus	**analgesia**
	consider	**advice and referral**

Treatment algorithm

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Acute

confirmed CES

1st **decompression surgery**

» CES is a neurosurgical emergency. Decompression surgery must be performed as soon as possible for any patient who has radiologically confirmed CES.[1] [15]

- The objective is to alleviate compression of the cauda equina and prevent further neurological deterioration, thereby preserving the function that is present at the time of surgery.[1] Evidence suggests there is also some scope to partially reverse the neurological deficit in some patients.[22]
- Catheterise the patient (if catheter is not already in place) as soon as a decision to operate has been made.[15]

» For patients who retain some executive control of bladder function (CESI), surgery should be undertaken as an emergency, day or night.[15] For patients who have painless urinary retention and overflow incontinence (CESR), for whom the prognosis is less positive, surgery should be undertaken within 24 hours of the magnetic resonance imaging (MRI) scan, with the exact timing at the discretion of the surgeon.[15]

» Total laminectomy, hemilaminectomy, and laminotomy are all acceptable techniques for decompression surgery.[15] The most appropriate technique is selected based on the patient's pathology and the experience of the surgeon.[6]

» Ensure that all patients undergoing surgery for CES are advised that the intention is to preserve the function present at the time of surgery. There is some scope for improvement but also a small risk of making matters worse should complications occur.[17]

- Pain, loss of perineal sensation, and bladder, bowel, and sexual dysfunction may persist, although significant recovery of function is possible.[1] [6] [45]

Acute

- Outcomes tend to be worse for patients who have CESR than for those with CESI.[15] [17]

Timing of surgery

The principle that emergency surgery is indicated for all patients with CES now has widespread support.[1] [15] However, the precise timing thresholds remain a source of debate.[4] [22]

- The British Association of Spine Surgeons (BASS)/Society of British Neurological Surgeons (SBNS) standards of care document for CES states that nothing is to be gained by delaying surgery, whereas there is potentially much to be lost.[16] [17] It recommends that there are no safe time thresholds for surgery and that emergency surgical decompression must take place at the earliest opportunity for all patients with imaging-confirmed CES.[16] [17]
- The NHS England national pathway for CES recommends that the urgency of emergency surgery depends on the degree of neurological symptoms at presentation. For patients with incomplete symptoms of CES (CESI; e.g., retaining some executive control over bladder function) surgery should be undertaken as an emergency day or night, and any reason for delay should be documented; only life-threatening cases should take priority over emergency surgery for CESI.[15] For patients with CES with painless urinary retention and overflow incontinence (CESR), for whom the prognosis is less positive, surgery should be undertaken within 24 hours of the MRI scan, with the exact timing at the discretion of the surgeon.[15] [NHS England, Getting It Right First Time: national suspected cauda equina interactive pathway]

In practice, the decision on timing of surgery can take into account the duration and clinical course of symptoms and signs, along with the potential for increased morbidity when operating at night, particularly given the complexity of the surgery for a large central disc prolapse.[16] [17]

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It is likely that the level of neurological dysfunction at the time of surgery (rather than time since symptom onset) is the most significant determinant of prognosis.[49] [52]

- The weight of evidence suggests that loss of function in CES is a continuous process with a poorer outcome the longer the cauda equina nerve roots are compressed.[1] [17]
- For a significant minority of patients with CES, an irreversible neurological deficit has already occurred by the time of presentation, but it is not easy to identify which individuals fall into this subset.[18]
- Incomplete CES (CESI) has a better prognosis than CES with painless urinary retention and overflow incontinence (CESR). Nonetheless, evidence suggests that more prolonged compression in patients with CESR can result in additional neurological loss and that a significant proportion of this group (around 70%) will gain some benefit from decompression surgery.[15] [17]

Acute

- A prospective cohort study that followed up 621 UK adults with CES found that postoperative functional improvement occurred in significant numbers of patients who had presented with urinary retention (with or without sensation to the catheter), suggesting a benefit of surgical decompression in reversing neurological deficits among patients with CESR.[22] Some 70% of patients who had required preoperative catheterisation for urinary retention (including 57% of those who had no sensation to the catheter) were no longer using a catheter by discharge. At 1-year follow-up, only 26% of individuals who had required preoperative catheterisation still needed to use a catheter, suggesting a significant potential for recovery of bladder function in patients who present with retention with or without an insensate bladder.[22]
- The study also found that bladder outcomes and disability at 1-year follow-up were associated with severity at presentation but not with time from symptom onset to surgery, although the authors noted that the observational nature of the study limited interpretation of the implications of this finding for recommendations on urgency of surgery.[22]

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Acute

CESI found that the likelihood of a patient ending up with normal bladder function restored was twice as high for those who had surgery within 24 hours compared with those operated on between 24 and 48 hours (OR 1.9, 95% CI 0.5 to 7.5).[51]

- Any patient in the early stage of CESR (<12 hours) or who has CESR with some residual sacral nerve root function should also have emergency surgery day or night. There is a paucity of evidence on the impact of timing of surgery on outcomes for this patient group; some studies do support earlier surgery, but the evidence is conflicting.[1] One small study of 17 patients with CESR showed benefit from surgery within 12 hours.[48]
- Any patient who has either prolonged CESR with no residual nerve root function or complete loss of all cauda equina function (with absent perineal and perianal sensation, a paralysed and insensate bladder and bowel, and a patulous anus) can have surgery the following day.[1]

Surgical complications

Complication rates in decompression surgery are around six times higher for patients with CES than for those who have similar surgery for other indications.[15]

- To avoid bladder distension injury, the patient should be catheterised before surgery begins.[15]
- A cohort study of 621 UK patients with CES reported that complications occurred in 26% of individuals, with the most common being durotomy or cerebrospinal fluid (CSF) leak (12%) and postoperative neurological deterioration (12%).[22]

plus **bladder management**

Treatment recommended for ALL patients in selected patient group

Acute

» Undertake a trial without catheter (TWOC) as soon as feasible postoperatively and obtain pre- and post-void bladder scans.[15]

- If the post-void residual volume (PVR) is <100 mL, the patient can be discharged without a catheter.[15]
- Recatheterisation with a long-term catheter is indicated if the pre-void bladder scan is >500 mL with no sensation to void OR the patient has not voided after 6 hours OR the PVR is >100 mL.
    - Do not attempt a second TWOC if the first trial has failed.[15]
    - An intermittent catheter is preferred, if feasible, as it is associated with lower rates of urinary tract infection, urethral trauma, and renal complications.[53] [54] [55] [56]
    - If flip/flow catheterisation is used, it must be opened at least once every 4 hours, including overnight, aiming to maintain a bladder volume <500 mL.
- Refer to the appropriate service so that the patient can be taught how to self-catheterise.[15] This may be the continence, urology, or spinal cord injury team; check local protocols.[16]

» At surgical outpatient follow-up, check for any ongoing urinary symptoms and refer to the appropriate service if present.[15]

plus **bowel management**

Treatment recommended for ALL patients in selected patient group

» Ensure that all patients treated for CES are provided with advice on the potential for ongoing neurogenic bowel problems.[15] These can include involuntary bowel movements, constipation, and impaction.[57] [58]

- A bowel management plan should be instigated within 24 hours of admission.[58]
- Laxatives and/or bowel evacuation may be necessary.[57] [59] Patients should be taught how to undertake digital rectal stimulation (DRS) followed by digital rectal evacuation (DRE).[15]

Acute

- Patients with bowel dysfunction resulting from injury to the cauda equina may have areflexic (flaccid) bowel dysfunction in the short or long term, although mixed reflex and areflexic dysfunction is also possible.[58]
- Referral to a bowel programme may be needed for individualised rehabilitation and ongoing management.[15] [57] [58] [59] This may be provided by the continence, colorectal, or spinal cord injury service; check local protocols.[16]

» At surgical outpatient follow-up, check for any ongoing bowel symptoms and refer to the appropriate service if present.[15]

plus **analgesia**

Treatment recommended for ALL patients in selected patient group

Primary options

» paracetamol: 500-1000 mg orally every 4-6 hours when required, maximum 4000 mg/day

--AND/OR--

» ibuprofen: 300-600 mg orally (immediate-release) every 6-8 hours when required, maximum 2400 mg/day

-or-

» naproxen: 500 mg orally initially, followed by 250 mg every 6-8 hours when required

Secondary options

» codeine phosphate: 30-60 mg orally every 6 hours when required, maximum 240 mg/day

OR

» morphine sulfate: 5-10 mg orally (immediate-release) every 4 hours initially, adjust dose according to response

OR

» tramadol: 100 mg orally (immediate-release) initially, followed by 50-100 mg every 4-6 hours when required, maximum 400 mg/day

» Patients who present with suspected CES are often in significant pain. Prompt up-titration of analgesics may be needed to relieve pain and facilitate effective clinical examination

Acute

and magnetic resonance imaging (MRI) scanning.[23]

Postoperative pain management

Advise the patient that it is normal to continue to experience some degree of back and leg pain after surgery and that recovery of nerve function can continue for up to 18 months to 2 years.

- If a patient experiences an unusual degree of pain during this period, it is important to exclude further disc prolapse (with an MRI if appropriate).[15]

During the first 3 months following surgery for CES, acute pain management follows the standard analgesic ladder for postoperative care.[15]

- Use of simple analgesia (i.e., paracetamol and/or a non-steroidal anti-inflammatory drug [NSAID] with gastrointestinal [GI] protection) is recommended.[60] Examples of suitable NSAIDs include ibuprofen or naproxen. Long-term use of NSAIDs can be associated with GI adverse effects (bleeding, perforation, or ulceration), cardiovascular thrombotic events, and renal disease. Use the lowest effective dose for the shortest effective treatment duration.
- Opioids (with adjunct treatments to prevent constipation) should only be used in the very short term postoperatively. They can be considered for individuals with a high functional pain assessment score, with appropriate monitoring and advice on de-escalation of opioid use.[60] Immediate-release formulations of opioids are preferred.[60] Be aware that opioids can exacerbate bowel and bladder dysfunction. Ensure frequent re-assessment of any patient whose level of pain does require a short-term opioid.[60]

For management of chronic pain (>3 months post-surgery for CES), do *not* offer opioids, gabapentinoids, anticonvulsants, oral corticosteroids, or benzodiazepines.[15]

- Consider lumbar nerve root block with an injection of local anaesthetic/hydrocortisone.[15]

Acute

- If the patient has persistent neuropathic pain, refer for consideration of spinal cord stimulation.[15] [61]

consider **advice and referral**

Treatment recommended for SOME patients in selected patient group

» Ensure that all patients are offered advice on the potential for sexual dysfunction following surgery for CES.[15]

- Refer any patient with ongoing sexual dysfunction to the appropriate local service or spinal cord injury service.[15]

» Many patients experience psychological issues.

- All patients can benefit from being informed about relevant support groups. In the UK, examples include the Cauda Equina Champions Charity and the Spinal Injuries Association.[15] [Cauda Equina Champions Charity] [Spinal Injuries Association]
- Those with ongoing disability should be offered psychological support, according to the local pathway. In the UK, this is typically provided by the spinal cord injury service.[15]

Emerging

Percutaneous endoscopic lumbar discectomy

Percutaneous endoscopic lumbar discectomy is a minimally invasive procedure for treating CES caused by lumbar disc herniation. Retrospective studies have shown improvement of lower extremity symptoms after surgery, in addition to comparable efficacy to laminectomy, but with fewer adverse effects.[62] [63]

Primary prevention

High-risk occupations for disc herniation or spinal trauma (e.g., construction workers, agricultural workers, seamen, bricklayers, road menders, vehicle drivers, military personnel, law enforcement officers, firefighters) require adequate safety and preventative measures to be instituted by employers. These measures should include education, safe work practices, and restraint systems. Similar safety measures should apply for people taking part in high-risk recreational activities (e.g., vehicle racing, mountaineering, diving, horse riding, gymnastics).

Patient discussions

Good patient/clinician communication is crucial, with the clinician asking tailored questions to gain key information about symptoms of suspected CES:

- Make sure that the patient understands the seriousness of CES and the importance of timely diagnosis and treatment.
- Use patient-centred language and non-medical lay descriptions; be aware that terms such as ‘saddle anaesthesia’ or ‘recent onset of sexual dysfunction’ will not be understood by some patients.
- Listen carefully to what the patient is saying, so that important information is not missed.
- Provide the patient with written information, if possible, as well as links to good web-based information.
- Be aware that pain is often the most significant symptom for patients, and may distract attention from other, possibly subtle, symptoms indicative of CES, such as altered sensation.

A toolkit for use with patients considered to be at risk of developing CES has been developed.[14]

Instruct patients who may be at risk of developing CES about what they should do if symptoms develop, progress, or recur.[66]

FOLLOW UP

Monitoring

Monitoring

There is a high prevalence of long-term bladder, bowel, sexual, and physical dysfunction in patients who have undergone surgery for CES, and patients should be monitored for ongoing problems at follow-up.[57] [65] Referral to physiotherapy, continence, urology, and/or pain management services may be required.[45]

There is evidence that monitoring and therapy for ongoing sexual dysfunction and pain is inadequate in these patients.[31][45]

For all patients who have had disc herniation, a lifelong programme of muscle activity to maintain healthy core lumbar and pelvic girdle muscles is important to avoid continued degeneration and recurrence.

FOLLOW UP

Complications

Complications	Timeframe	Likelihood
bladder dysfunction	**long term**	**high**

At surgical outpatient follow-up, check for any ongoing urinary symptoms and refer to the appropriate specialist service if present.[15] Depending on local protocols, this may be an incontinence, urology, or spinal cord injury service.[15] [16] [65]

Bladder/lower urinary tract dysfunction has been reported at follow-up for between 38% and 76% of patients after surgery for CES.[45] [64] Symptoms include overactive bladder, stress incontinence, and low stream.[45] It is more common in patients who had CES with retention before surgery than in those with incomplete CES.

If bladder catheterisation is needed, an intermittent catheter is preferred, as it is associated with lower rates of urinary tract infection and urethral trauma.[53] [54] [55] [56] An indwelling catheter may be used if intermittent catheterisation is not feasible.[53] [54] Anticholinergic medications are often part of management. Invasive procedures may be considered for ongoing problems.[53] [54]

back and or/leg pain	**long term**	**high**

In one study, 70% of patients who had surgery for CES reported pain at follow-up (mean follow-up 43 months), most of whom had back pain.[45] Referral to pain management services should be considered for patients whose pain is significantly affecting their day-to-day lives.

For management of chronic pain (>3 months post-surgery for CES), do NOT offer opioids, gabapentinoids, anticonvulsants, oral corticosteroids, or benzodiazepines.[15]

- Consider lumbar nerve root block with an injection of local anaesthetic/corticosteroid.[15]
- If the patient has persistent neuropathic pain, refer for consideration of spinal cord stimulation.[15] [61]

sensory loss	**long term**	**high**

In one study, 70% of patients who had surgery for CES reported sensory loss at follow-up (mean follow-up 43 months).[45]

bowel dysfunction	**long term**	**medium**

Bowel dysfunction has been reported at follow-up for between 13% and 43% of patients after surgery for CES.[45] [64]

Ongoing neurogenic bowel problems can include involuntary bowel movements, constipation, and impaction.[57] [58]

- Patients with bowel dysfunction resulting from injury to the cauda equina may have areflexic (flaccid) bowel dysfunction in the short or long term, although mixed reflex and areflexic dysfunction is also possible.[58]

At surgical outpatient follow-up, check for any ongoing bowel symptoms and, if present, refer to a bowel programme for individualised rehabilitation and ongoing management.[15] [57] [58] [59] This may be provided by the continence, colorectal, or spinal cord injury service; check local protocols.[16]

- A bowel programme can help to establish regular stimulation of the bowels to cause a bowel movement. This will help to prevent involuntary bowel movements, constipation, and impaction.

Complications	Timeframe	Likelihood
• Laxatives and/or bowel evacuation may also be required.[57] [59] • If bowel evacuation is required, patients should be taught how to undertake digital rectal stimulation (DRS) followed by digital rectal evacuation (DRE).[15]		
sexual dysfunction	**long term**	**medium**
Sexual dysfunction has been reported at follow-up for between 39% and 56% of patients after surgery for CES.[31] [64] However, it is often not assessed or documented at follow-up.[45] Ensure that all patients are offered advice on the potential for sexual dysfunction following surgery for CES, and ask specifically about this at postoperative follow-up.[15] • Refer any patient with ongoing sexual dysfunction to the appropriate local service or spinal cord injury service.[15] • A trial of a phosphodiesterase-5 (PDE-5) inhibitor may be worthwhile for both male and female patients.[15]		
leg weakness	**long term**	**medium**
In one study, 44% of patients who had surgery for CES reported leg weakness at follow-up (mean follow-up 43 months), including 13% who needed a walking aid to mobilise.[45]		
psychological problems	**long term**	**medium**
Many patients experience psychological issues after CES. • All patients can benefit from being informed about relevant support groups. In the UK, examples include the Cauda Equina Champions Charity and the Spinal Injuries Association.[15] [Cauda Equina Champions Charity] [Spinal Injuries Association] • Those with ongoing disability should be offered psychological support, according to the local pathway. In the UK, this is typically provided by the spinal cord injury service.[15]		

Prognosis

The degree of neurological dysfunction at surgery is the most significant determinant of prognosis: outcomes are worse for patients with CES with painless urinary retention and/or overflow incontinence (CESR) than for patients with incomplete CES (CESI). Delay to surgery for patients with CESI is likely to adversely affect prognosis.[8][51] [52]

Ongoing bladder, bowel, and/or sexual dysfunction, as well as pain, leg weakness, and sensory loss, have been reported in up to 60% of people after surgery for CES, but improvement is still possible for several years after surgery.[45] [64]

Diagnostic guidelines

United Kingdom

Spinal surgery: national suspected cauda equina syndrome (CES) pathway

Published by: NHS England: Getting It Right First Time **Last published:** 2023

MRI provision for cauda equina syndrome

Published by: The Royal College of Radiologists **Last published:** 2023

Standards of care for investigation and management of cauda equina syndrome

Published by: Society of British Neurological Surgeons; British Association of Spinal Surgeons **Last published:** 2018

Europe

HSE national clinical guideline for cauda equina syndrome

Published by: Health Service Executive, Ireland **Last published:** 2024

North America

Best practices guidelines: spine injury

Published by: American College of Surgeons; American Congress of Rehabilitation Medicine **Last published:** 2022

ACR appropriateness criteria: low back pain

Published by: American College of Radiology **Last published:** 2021

Treatment guidelines

United Kingdom

Spinal surgery: national suspected cauda equina syndrome (CES) pathway

Published by: NHS England: Getting It Right First Time **Last published:** 2023

Standards of care for investigation and management of cauda equina syndrome

Published by: Society of British Neurological Surgeons; British Association of Spinal Surgeons **Last published:** 2018

Europe

HSE national clinical guideline for cauda equina syndrome

Published by: Health Service Executive, Ireland **Last published:** 2024

North America

Best practices guidelines: spine injury

Published by: American College of Surgeons; American Congress of Rehabilitation Medicine **Last published:** 2022

Online resources

1. NHS England, Getting It Right First Time: national suspected cauda equina interactive pathway *(external link)*
2. NHS/MACP: cauda equina syndrome *(external link)*
3. Cauda Equina Champions Charity *(external link)*
4. Spinal Injuries Association *(external link)*

Key articles

- Todd NV, Dickson RA. Standards of care in cauda equina syndrome. Br J Neurosurg. 2016 Oct;30(5):518-22. Abstract
- Finucane LM, Downie A, Mercer C, et al. International framework for red flags for potential serious spinal pathologies. J Orthop Sports Phys Ther. 2020 Jul;50(7):350-72. Full text Abstract
- NHS England, Getting It Right First Time. Spinal surgery: national suspected cauda equina syndrome (CES) pathway. Feb 2023 [internet publication]. Full text
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- Woodfield J, Hoeritzauer I, Jamjoom AAB, et al; UCES Collaborators; British Neurosurgical Trainee Research Collaborative. Presentation, management, and outcomes of cauda equina syndrome up to one year after surgery, using clinician and participant reporting: a multi-centre prospective cohort study. Lancet Reg Health Eur. 2023 Jan;24:100545. Full text Abstract

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