

# Cauda equina syndrome

## Abstract

Cauda equina syndrome is an uncommon but serious cause of lower back pain resulting from compression of the cauda equina nerve roots, most commonly by lumbar disc herniation. Red flag symptoms, such as bladder dysfunction, saddle anaesthesia and sciatica, should lead to high clinical suspicion of cauda equina syndrome. The British Association of Spinal Surgeons has published an updated standard of care for these patients because of the potentially debilitating effects of missed cases of cauda equina syndrome. This review summarises these standards and provides a framework to support quick triage of at-risk patients. Immediate magnetic resonance imaging, within 1 hour of presentation to the emergency department, is crucial in patients with suspected cauda equina syndrome to allow prompt diagnosis and treatment. Urgent decompressive surgery is usually recommended for the best outcomes, to reduce morbidity and complication rates.

**Key words:** Back; Cauda equina; Incontinence; Pain; Syndrome

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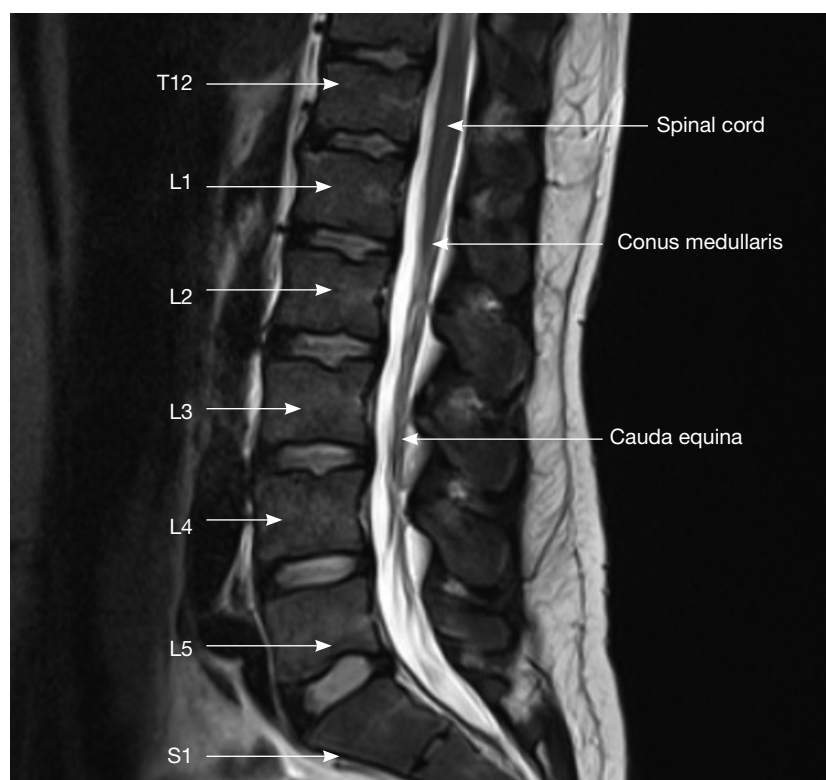
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## Introduction

Cauda equina syndrome is a rare but potentially devastating spinal condition, which can cause severe symptoms, such as bilateral lower extremity sensory and motor deficits, and urinary, bowel and sexual dysfunction (Spector et al, 2008). The cauda equina is a collection of nerves and nerve roots distal to the terminal end of the spinal cord, the conus medullaris, which typically stem from levels L1 to L5 (Barraclough, 2021) (Figure 1). The cauda equina provides sensory innervation and motor function to the bladder, perineum, anus and



**Figure 1.** Sagittal T2-weighted magnetic resonance imaging showing the cauda equina nerve roots distal to the conus medullaris on a normal lumbar spine.

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lower limbs (Long et al, 2020). Cauda equina syndrome results from compression of these nerve roots from numerous causes, such as lumbar disc herniation (Hogan et al, 2019). Incomplete resolution of symptoms may lead to significant morbidity and medicolegal consequences (Kuris et al, 2021). Therefore, cauda equina syndrome requires urgent diagnosis, investigation and surgical treatment (Fraser et al, 2009). This article discusses the epidemiology, clinical features, investigation and management of cauda equina syndrome.

## Epidemiology

Acute lower back pain is a common condition with a 60% lifetime prevalence (Campbell and Colvin, 2013). Cauda equina syndrome is a rare but severe cause of acute lower back pain: its prevalence ranges from 0.3–1/100 000 in the general population and 2–6% in patients who have had surgery for lumbar disc herniation (Gardner et al, 2011). Obesity and age <50 years are the main risk factors that increase the probability of cauda equina syndrome (National Spine Network, 2020). Lumbar disc herniation (Figure 2), prolapse or sequestration are the most common causes of cauda equina syndrome (Gardner et al, 2011; Hogan et al, 2019). Less common causes include metastatic neoplasms, infection, stenosis and epidural haematoma (Table 1) (Orendáčová et al, 2001).

## Clinical features

### Classification

Cauda equina syndrome can present with different clinical pictures (Gardner et al, 2011). It may present as acute or gradual onset bladder dysfunction with or without chronic back problems and sciatica. Around 70% of patients with cauda equina syndrome have a history of chronic back pain (Kavanagh and Walker, 2013). Broadly, there are two classifications of cauda equina syndrome: incomplete and complete. These depend on the severity of cauda equina damage and subsequent symptoms, specifically the presence of urinary retention (Gleave and MacFarlane, 2002). Complete cauda equina syndrome is most strongly associated with urinary incontinence, loss of perianal sensation and urinary retention, as a result of complete damage of the cauda equina. Incomplete cauda equina



**Figure 2.** Sagittal T2-weighted magnetic resonance imaging showing L5–S1 disk herniation, causing compression of the cauda equina nerve roots (white arrow).

**Table 1. Compressive and non-compressive causes of cauda equina syndrome**

Compressive causes	Lumbar disc herniation
	Lumbar spinal stenosis
	Spinal neoplasms
	Spinal arteriovenous malformations
	Epidural haematoma
Non-compressive causes	Spinal arachnoiditis
	Ischaemic insults
	Inflammatory conditions, eg ankylosing spondylitis
	Spinal infections

syndrome may result in a reduced desire to void or the need to strain during micturition, as the lesion partially damages the cauda equina, so it presents without urinary retention or overflow. Complete cauda equina syndrome has a worse prognosis and surgical outcome (Gleave and MacFarlane, 2002; Qureshi and Sell, 2007).

### History

A detailed history is essential to identify red flag symptoms in patients suspected of having cauda equina syndrome, and should include back pain, bowel or bladder changes and bilateral sciatica. Back pain in patients with cauda equina syndrome is generally felt as high severity pain in the lumbar region, and typically worsens when in the supine position, as the affected nerve root is pressurised (Gardner et al, 2011; Tarulli, 2015). Sciatica in multiple root distributions (L3–S1) is noted in around half of patients with cauda equina syndrome (Domen et al, 2009; Mukherjee et al, 2013). The bladder is innervated by sympathetic and parasympathetic nerves, which cause micturition via activation of the detrusor muscle (Tarulli, 2015). Cauda equina syndrome can damage these nerves and cause bladder atony with urinary retention and incontinence, which is seen in 87.5% of patients with cauda equina syndrome (Domen et al, 2009; Long et al, 2020). Post-void urinary retention of more than 500 ml either individually or with other characteristics, such as sciatica, is an important predictor of cauda equina syndrome and should be promptly confirmed by ultrasound of the bladder (Domen et al, 2009). Cauda equina syndrome can also cause bowel dysfunction by damaging the nerves that control defaecation (Tarulli, 2015). Males with cauda equina syndrome may experience erectile dysfunction as a result of damage in parasympathetic innervation, which causes erection. These are all important red flags of cauda equina syndrome, in addition to decreased anal tone, saddle anaesthesia, and bilateral weakness and sensory deficit to the lower limbs (Korse et al, 2013; Mukherjee et al, 2013). Therefore, a thorough neurological examination of the lower limbs, including perianal sensation and anal tone testing, is imperative if cauda equina syndrome is suspected following a detailed history.

### Examination

A neurological examination for cauda equina syndrome should include tone, power, reflexes and sensory testing of the lower extremities (Lees and Hurwitz, 2019). Power should be tested across all relevant lower limb myotomes (L2–S1) (Table 2). Sensory innervation should be tested across all relevant lower limb dermatomes (L1–S4) (Table 3) (Rupp et al, 2021). Reflex testing is essential if cauda equina syndrome is suspected, and may reveal an absent ankle jerk reflex (S1–2) (Lees and Hurwitz, 2019).

Saddle anaesthesia is described as the loss of sensation to the inner thighs, perineum, perianal area and buttocks (Kuris et al, 2021). Although back pain, bladder dysfunction and saddle anaesthesia are the most common presenting complaints in cauda equina syndrome, they all have a low specificity (Korse et al, 2013). A systematic review reported that bowel incontinence, perianal sensation and reduced anal tone were more specific markers of cauda

**Table 2. Neurological examination testing areas for dermatome sensory function**

Dermatome	Sensory testing
L1	Lesser trochanter and groin region
L2	Anterior-medial thigh
L3	Medial femoral condyle above the knee
L4	Medial malleolus
L5	Dorsum of the foot at the third metatarsal phalangeal joint
S1	Lateral heel (calcaneus)
S2–4	Popliteal fossa, infragluteal fold, perianal and perineum

**Table 3. Neurological examination testing areas for myotome motor function**

Myotome	Motor testing
L2	Hip flexion
L3	Knee extension
L4	Ankle dorsiflexion
L5	Hallux extension
S1	Ankle plantar flexion

equina syndrome (Dionne et al, 2019), although these lacked sensitivity and were less accurate because they required a skilled examination. Owing to the varying presentation, it is not possible to reliably diagnose cauda equina syndrome based on clinical findings alone. Nevertheless, the British Association of Spine Surgeons (2019) standard of care suggested that patients presenting with these red flag symptoms should be suspected of having potential or actual cauda equina syndrome.

**Investigations**

Cauda equina syndrome is difficult to diagnose based on clinical findings alone and requires urgent investigation. The gold standard imaging for suspected cauda equina syndrome is magnetic resonance imaging of the lumbosacral spine, because this can accurately depict soft tissue and neural pathology, and identify cauda equina compression or other pathology that mimics symptoms of cauda equina syndrome (Spector et al, 2008; McNamee et al, 2013). A systematic review showed that 19% of magnetic resonance imaging scans confirmed cauda equina compression in patients suspected of having cauda equina syndrome (Hoeritzauer et al, 2020). Although this prevalence is low, the consequences of a delayed or missed diagnosis can be catastrophic for the patient (Gardner et al, 2011). Furthermore, the British Association of Spine Surgeons (2019) standard of care recommended that anyone with red flags should have an emergency magnetic resonance imaging scan within 1 hour of presentation to the emergency department. This reduces any delay in treatment (Hogan et al, 2019). If magnetic resonance imaging is contraindicated because of the presence of metallic foreign bodies or a pacemaker, a computed tomography myelogram is the modality of choice (Long et al, 2020).

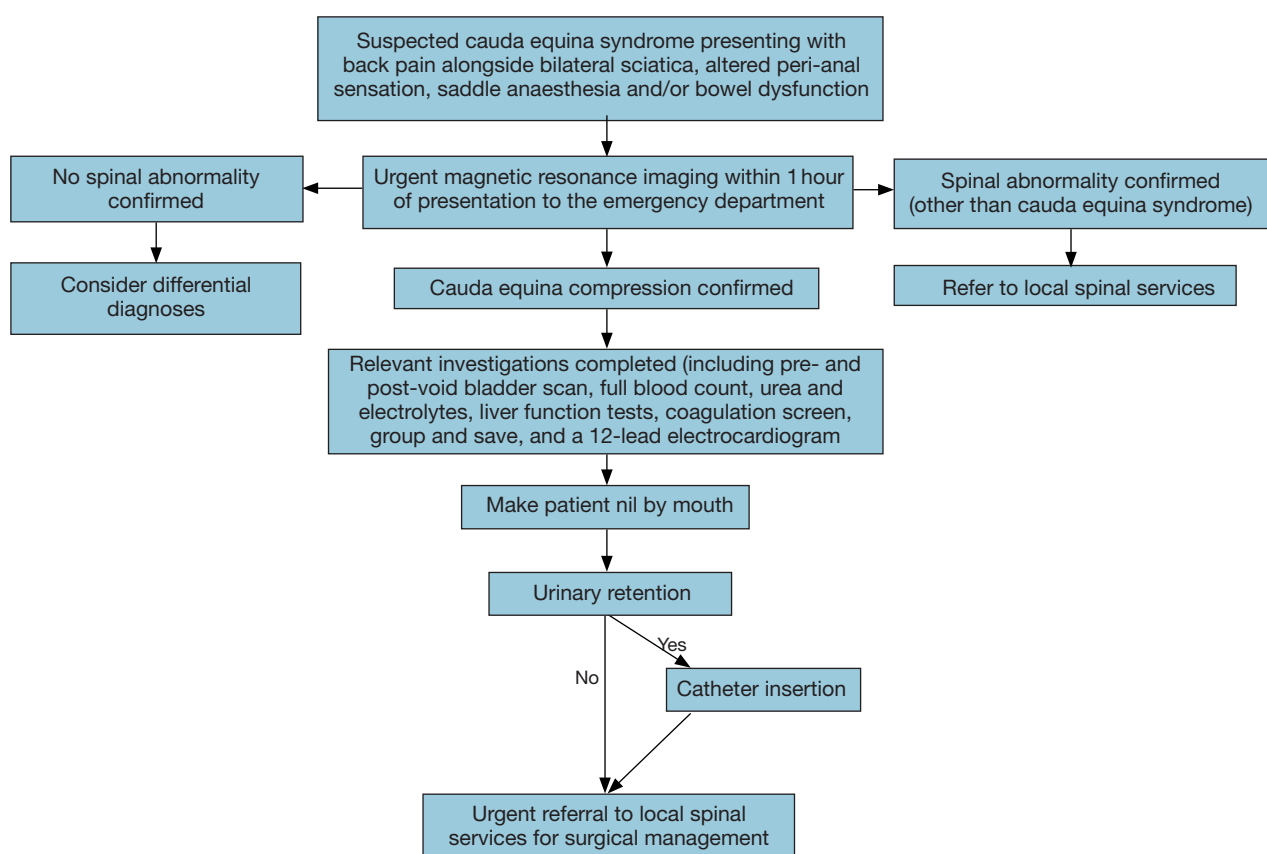
**Management**

On presentation to the emergency department, patients with suspected cauda equina syndrome require basic investigations before urgent referral to local spinal surgery services, which is outlined in a treatment algorithm suggested by the authors (Figure 3). Laboratory testing is not diagnostic for cauda equina syndrome but is important in the preoperative work-up of these patients. A full blood count, basic metabolic panel, clotting screen and a

group and save are advised preoperatively (Long et al, 2020). An ultrasound examination may be performed to assess bladder volume pre- and post-void (Domen et al, 2009), and a catheter inserted if the patient is in urinary retention. The patient should be made nil by mouth and then be immediately referred to local spinal surgery services (Long et al, 2020). If the patient has cauda equina syndrome with a non-compressive cause, such as a spinal infection, medical treatment may also be appropriate.

There are several studies comparing the relationship between the timing of surgery and outcomes for cauda equina syndrome. Overall, the consensus management is largely dependent on whether the syndrome is complete or incomplete. Patients with incomplete cauda equina syndrome may develop urinary retention before surgery is undertaken, whereas this is already present in patients with complete cauda equina syndrome (Gleave and Macfarlane, 2005). Favourable outcomes have been reported in patients with incomplete cauda equina syndrome who undergo immediate spinal decompression (within 24 hours of presentation) (Todd, 2005; Jerwood and Todd, 2006). This approach has the potential to prevent development of complete cauda equina syndrome and allow full recovery of bladder function.

However, the optimum management for patients with complete cauda equina syndrome is less clear. Regardless of treatment urgency, neurological outcomes are worse in those with complete rather than incomplete cauda equina syndrome, as only 70% of patients with complete cauda equina syndrome may regain bladder function after treatment (Todd, 2005; Jerwood and Todd, 2006; Jha et al, 2022). It has been argued that these patients would benefit from non-urgent surgery, in daylight hours, with the most experienced surgeon and time for greater surgical planning (Gleave and Macfarlane, 2005). However, one study showed that delaying surgery has no effect on extent of recovery, but prolongs the overall process (Jha et al, 2022). Furthermore, there are significant improvements in motor and sensory recovery in patients with both incomplete and complete cauda equina syndrome when surgery takes place before 48 hours of onset of symptoms, compared to those treated after (Hogan et al, 2019). Moreover, there is a higher risk of thromboembolic events when



**Figure 3.** Suggested investigation and treatment algorithm for suspected cauda equina syndrome.

## Key points

- Cauda equina syndrome is a rare spinal emergency.
- Cauda equina syndrome presents with back pain alongside neurological disturbance (eg saddle anaesthesia, bilateral sciatica and bladder or bowel dysfunction).
- Patients with suspected cauda equina syndrome should have urgent magnetic resonance imaging within 1 hour of presentation to the emergency department.
- Patients with confirmed cauda equina syndrome must be urgently referred to the local spinal services for surgical management.

surgery is delayed past 24 hours for both incomplete and complete cauda equina syndrome. Therefore, timely surgical intervention should be advised regardless of whether a patient has complete or incomplete cauda equina syndrome to reduce morbidity and complications. Conversely, a systematic review and meta-analysis showed that outcomes are more closely related to the severity of compression rather than the duration (Pronin et al, 2019). Hence, some patients never regain full neurological function, regardless of time to theatre.

## Conclusions

Cauda equina syndrome is a rare spinal emergency which, if not recognised early, may cause severe and irreversible complications. The main red flags for cauda equina syndrome include acute or chronic lower back pain with bladder and bowel dysfunction, saddle anaesthesia and sciatica. If cauda equina syndrome is suspected from these clinical findings, urgent investigation is imperative with immediate magnetic resonance imaging, as cauda equina syndrome is difficult to diagnose from red flags alone. Optimal timing of treatment may differ between complete and incomplete cauda equina syndrome, but there is no significant evidence to support delay in treatment. Emergency surgery should be performed at the earliest opportunity to provide the best outcomes for patients.

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### Conflicts of interest

The authors declare that there are no conflicts of interest.

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