Cauda equina syndrome: a clinical review for the frontline clinician

Cauda equina syndrome is a combination of symptoms and signs resulting from cauda equina compression. It requires a prompt diagnosis and emergency surgical referral. There is a large medicolegal burden surrounding the condition.

Cauda equina syndrome is considered to be a clinical emergency and is an area associated with a high risk of litigation. An understanding of cauda equina syndrome is important not only to orthopaedic surgeons and neurosurgeons, but also to GPs, emergency department staff, and other specialists to whom these patients may initially present. Diagnosis of the syndrome by frontline clinicians is often challenging and thus sometimes delayed with potentially grave consequences.

This review describes the syndrome of cauda equina compression, reviews the evidence for its management and discusses the medicolegal implications of misdiagnosis and mismanagement.

Definition of cauda equina syndrome and its estimated incidence

Cauda equina syndrome is a combination of symptoms and signs resulting from a compression of the cauda equina, the bundle of lumbo-sacral nerve roots distal to the termination of the spinal cord at the conus medullaris. Although a variety of manifestations may be evident, the term cauda equina syndrome is generally used only when there is impairment of bladder, bowel or sexual function, and perineal or 'saddle' numbness (Jensen, 2004). Bilateral leg symptoms in the form of radicular pain, numbness or weakness (without symptoms and signs of cord compression) are certainly indicative of a partial or impending cauda equina syndrome if not part of the actual syndrome itself. Painless urinary retention is claimed to be the most sensitive symptom (Greenberg, 2006).

The incidence of cauda equina syndrome is variable and is dependant on the aetiology. The prevalence among the general population has been estimated between 1:33 000 and 1:100 000 (Mooney, 1991). Cauda equina syndrome is reported in approximately 0.04% of all patients presenting with a primary complaint of lower back pain (Small et al, 2005), and in 1–2% of all lumbar disc herniations that progress to surgery (Shapiro, 1993, 2000).

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Causes of cauda equina syndrome

The pathophysiological mechanisms of cauda equina syndrome are not fully understood. It may result from any lesion to the cauda equina nerve roots such as direct mechanical compression, inflammation, venous congestion or ischaemia. The commonest cause of cauda equina syndrome is compression arising from a large central lumbar disc herniation at the L4/5 or L5/S1 level. The first description of neurological compromise from a ruptured lumbar intervertebral disc was published by Mixter and Barr (1934). It has been suggested that the proximal portion of the cauda equina is relatively hypovascular (Parke et al, 1981). Blood supply alterations resulting from nerve root pressure may therefore be more important in this region of the cauda equina than elsewhere.

Patients may be predisposed to cauda equina syndrome if they have a congenitally narrow spinal canal or have acquired spinal stenosis secondary to degenerative changes of the disc and segmental posterior joints with thickening of the ligamentum flavum and narrowing of the available canal cross section. However, the peak incidence of cauda equina syndrome is in the fourth or fifth decade of age, and degenerative spinal disease is less commonly diagnosed in this age group (Shapiro, 1993; Small et al, 2005).

Less common causes of cauda equina syndrome include: spinal injury with fractures or subluxation, spinal neoplasms of primary or metastatic origin causing painful compression, and infective causes with abscess formation or bony involvement. A wide range of iatrogenic causes are reported, including spinal anaesthesia (Loo and Irestedt, 1999) and postoperative complications such as haematoma (Jensen, 2004). Other space-occupying lesions, such as nerve-derived tumours, cysts, haemangiomas and vena varix, have also been reported.

Clinical presentation of cauda equina syndrome and 'red flag' features

In a patient with suspected cauda equina syndrome, key features to elicit from a history and physical exam-

ination are summarized in *Table 1*. A history of perianal sensory loss and sphincter disturbance, with or without urinary retention, are 'red flag' symptoms suggesting the presence of cauda equina syndrome. Three classic patterns of presentation have been described (DeLong et al, 2008). It can present acutely as the first symptom of lumbar disc herniation, as the end point of a long history of chronic back pain with or without sciatica, or insidiously with slow progression to numbness and urinary symptoms. In current practice, most clinicians divide cauda equina syndrome into two clinical categories (DeLong et al, 2008): cauda equina syndrome with retention, in which there is established urinary retention, and incomplete cauda equina syndrome, in which there is reduced urinary sensation, loss of desire to void, or a poor stream, but no established retention or overflow (Gleave and Macfarlane, 2002). This clinical distinction is important because incomplete cauda equina syndrome mandates immediate surgical decompression to allow the potential for full neurological recovery and prevent progression to cauda equina syndrome with retention. Cauda equina syndrome with retention is associated with a worse neurological prognosis and the importance of immediate surgery is less clear (Gleave and Macfarlane, 1990, 2002; Qureshi and Sell, 2007).

A neurological examination of the legs, including an assessment of perianal pin and light touch sensation and anal tone, should be performed (*Table 1*). A reduction or absence in perianal sensation or anal tone is a red flag sign. This assessment can be easily done in the lateral position: perianal sensation can be tested from the outside in towards the sphincter using a gentle gloved finger stroke. A subsequent rectal examination can also be performed. Altered urinary and perineal sensation, another red flag sign, can be tested by gentle traction on an indwelling Foley catheter. A post-micturition bladder scan can aid the diagnosis of cauda equina syndrome, particularly with a painless residual volume of >750 ml (Greenberg, 2006). Loss or diminution of the bulbocavernosus reflex (reflex contraction of the anal sphincter caused by stimulation of the glans, penis, or clitoris) is also a red flag sign as the reflex is mediated through the sacral roots which anatomically lie close to the L1 vertebra (Lavy et al, 2009). Sensitivity of all these tests is relatively poor, however, likely because of observer unfamiliarity with the clinical examination (Bell et al, 2007; Fairbank et al, 2011).

Investigation of cauda equina syndrome

Most patients with clinical concern of cauda equina syndrome do not have cauda equina syndrome, and even clinical diagnosis made by resident neurosurgeons has a 43% false positive rate (Bell et al, 2007). Combined sensitivity and specificity for clinical examination of cauda equina syndrome is sufficiently poor, and the potential clinical consequences of failure of early diagnosis so dire, that in the modern era it is either a brave or highly experienced clinician that arranges neither immediate imaging or experienced clinical review of the patient with suspected cauda equina syndrome. In the UK magnetic resonance imaging is the gold standard radiological modality as it effectively shows soft tissues including intervertebral disc, ligamentum flavum, dural sac and nerve roots. *Figure 1* shows a magnetic resonance imaging scan of a large prolapsed intervertebral disc causing cauda equina syndrome. In settings where neither magnetic resonance imaging nor computed tomography is available, myelography can be useful in showing the presence and site of cauda equina compression (Akbar and Mahar, 2002).

Table 1. Clinical features suggestive of cauda equina syndrome

Assessment	Clinical findings (in decreasing order of importance)
History	Bladder dysfunction: particularly painless urinary retention with or without overflow incontinence
	Saddle anaesthesia
	Bilateral sciatica
	Severe low back pain
	Lower extremity motor or sensory abnormalities: bilateral or unilateral, foot drop, knee extension weakness, numbness
	Unilateral sciatica
	Sexual impotence, loss of ejaculation or orgasm
	Bowel dysfunction: incontinence or constipation
Examination	Decreased perineal or urinary sensation (e.g. loss of Foley catheter sensation on gentle traction)
	Decreased perianal sensation
	Decreased anal tone
	Weakness in lower limbs
	Sensory deficit in lower limbs

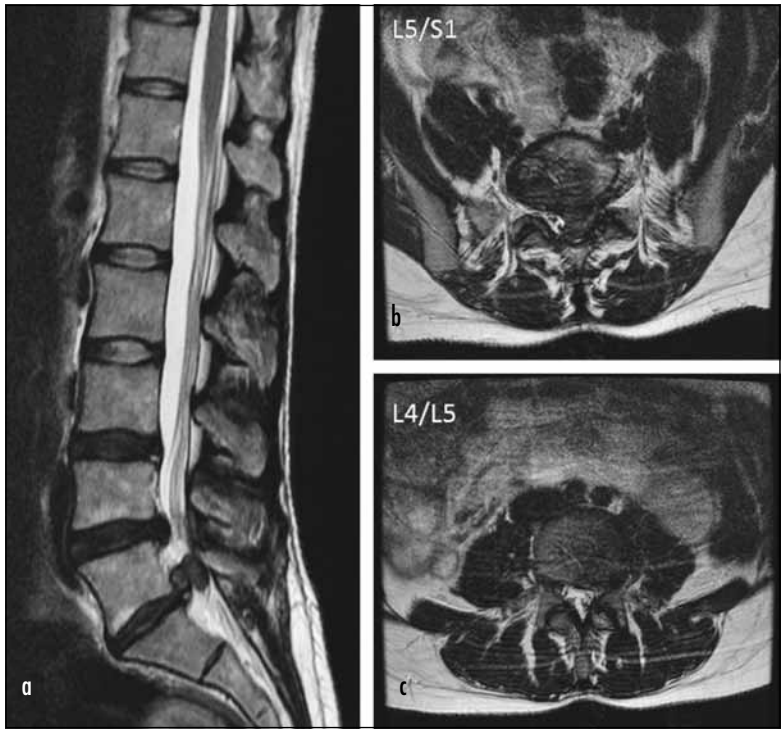
Treatment of cauda equina syndrome

In a patient with clinical suspicion of cauda equina syndrome and a magnetic resonance imaging scan showing cauda equina compression, urgent surgical decompression is recommended (Ahn et al, 2000). Most cases of the syndrome are caused by herniation of a lumbar disc, for which discectomy at the level of the herniation is usually indicated. The operation can be technically demanding, requiring great care to avoid causing further damage to nerve roots or tearing tightly compressed dura.

Timing of surgery for cauda equina syndrome

Once the diagnosis of cauda equina syndrome is made, the urgency of surgical decompression depends on the duration, severity and rapidity of progression of symptoms and signs. Incomplete cauda equina syndrome mandates immediate surgery to prevent progression to cauda equina syndrome with retention and offer the potential for full recovery of bladder function (Todd, 2005; Jerwood and Todd, 2006). Cauda equina syndrome with retention is associated with a worse neurological outcome and the importance of emergent *vs* delayed surgery is less clear. In cauda equina syndrome with retention of rapid onset (within 24 hours) immediate surgery is generally considered to be associated with a more favourable outcome than if surgery were delayed (Todd, 2005; Jerwood and Todd, 2006). In cauda equina syndrome with retention of slower onset (>48 hours), delayed surgery may not adversely affect an already poor neurological prognosis and may allow greater surgical planning (Gleave and Macfarlane, 1990, 2002, 2005; McCarthy et al, 2007).

Figure 1. Magnetic resonance image of the lumbosacral spine in a patient with cauda equina syndrome. a. Sagittal T2 and (b) axial T2 images show a herniated intervertebral disc at L5/S1 compressing the cauda equina at this level. c. Normal intervertebral disc and cauda equina in the same patient at L4/5.



The optimal timing of surgery for cauda equina syndrome remains controversial because of the lack of prospective randomized trials, and because in several of the retrospective studies published to date, there have been inadequately defined time intervals between symptoms and surgery or mixed patient cohorts including both incomplete cauda equina syndrome and cauda equina syndrome with retention, which have precluded robust conclusions.

Virtually all authors hold the view that for patients with incomplete cauda equina syndrome decompression should be performed within 24 hours of presentation, especially in the presence of perianal anaesthesia and significant sphincter disturbance (Kennedy et al, 1999; Mangialardi et al, 2002). These authors concluded that cauda equina syndrome is a surgical emergency with evolving bladder dysfunction being the most important indication for emergency surgery within 24 hours, and this has been supported by two widely quoted meta-analyses (Todd, 2005; Jerwood and Todd, 2006).

There is greater controversy surrounding the optimal timing of surgery for patients with cauda equina syndrome with retention. Several authors hold the view that once the bladder is paralysed clinical outcome is poor in any case and bears no relation to timing of surgery (Gleave and Macfarlane, 1990, 2002, 2005; McCarthy et al, 2007). Thus these patients can wait until an elective surgical list the following morning rather than having a potentially difficult operation in the middle of the night in less than optimal circumstances. The most recent published meta-analysis by DeLong et al (2008) supports this view.

There are other authors, however, who assert that there is a relationship between recovery of bladder function and the timing of surgical decompression in cauda equina syndrome with retention, but they differ on precisely what the optimal timing is, with some reporting more favourable outcomes if surgery is performed within 24 hours of cauda equina syndrome with retention than if delayed beyond 24 hours (Todd, 2005; Jerwood and Todd, 2006), and others proposing that the optimal timing of surgery extends to 48 hours (Ahn et al, 2000; Shapiro, 2000). While this is a widely held view from retrospective series, very few clinicians would adopt a non-emergency surgical strategy for even cauda equina syndrome with retention lasting for more than 48 hours. However, the importance of this aspect of the history is relevant for patient counselling.

A minority of authors have argued that, in both incomplete cauda equina syndrome and cauda equina syndrome with retention, no benefit is obtained from urgent decompression (Gleave and Macfarlane, 2002; Qureshi and Sell, 2007) and that emergency surgery might actually add to rather than alleviate morbidity when per-

formed under less than optimal conditions (middle of the night with inexperienced staff) (Gleave and Macfarlane, 2002). It can be argued that these factors may become less relevant given the evolving provision of 24-hour consultant-delivered services in the NHS (Department of Health, 2000). Nevertheless, the idea that emergency interhospital transfer with a view to emergency surgery may not be in the patient's best interest was investigated by Crocker et al (2008), who found that of 82 patients referred with suspected cauda equina syndrome and undergoing emergency magnetic resonance imaging, the diagnosis was confirmed in 27 (33%), but only five patients required emergency surgery, 15 were on the next available daytime operation list and six had their surgery after more than 24 hours.

In summary, cauda equina syndrome should be considered a surgical emergency. Surgical decompression for incomplete cauda equina syndrome should occur immediately to increase the chance of a favourable outcome. Even patients with cauda equina syndrome with retention should be considered for emergency surgery as soon as practically possible in all but the most delayed of cases. From a non-specialist's standpoint, a thorough history, clinical examination and an early surgical referral should be of the utmost priority in suspected cases.

Medicolegal implications of cauda equina syndrome

Persisting cauda equina syndrome has a devastating effect on personal and social life, and its mismanagement is one of the commonest causes of litigation in spinal surgery. Most patients are young to middle aged and in work before they develop cauda equina syndrome which therefore attracts high litigation payouts. The presence of residual symptoms means that many of these patients are unable to work and have genitourinary and bowel symptoms. It has been estimated that there are approximately 100 new cases of cauda equina syndrome annually in England, and that at least 10% of these cases involve litigation (Lavy et al, 2009).

In an analysis of 22 medical negligence reports in cases of cauda equina syndrome over a 5-year period, the average delay to diagnosis was 67 hours and to treatment 6.14 days (Lavy et al, 2009); 62% of patients had received their treatment after 48 hours. This delay was attributed to orthopaedic surgeons in 32% of cases, GPs in 18%, and others in 14%, but in 34% of cases it was unclear. Delay in surgical intervention for cauda equina syndrome is therefore a key medicolegal issue brought against attending physicians. Indeed, a retrospective analysis has evaluated factors leading to adverse medicolegal outcomes for the health-care provider in cauda equina syndrome (Daniels et al, 2012). It found a positive association between time to surgery >48 hours and a decision of medical negligence ($P<0.05$). The actual degree of functional loss did not appear to affect the verdicts.

Todd (2011) analysed 40 patients as an expert witness for litigation cases of cauda equina syndrome. He found that 93% of patients who had had voluntary bladder control at initial presentation had deteriorated to bladder paralysis at the time of treatment, all cases of which were probably avoidable. He also found that eleven patients had iatrogenic long-term bladder paralysis, and that recovery of bladder function occurred in only seven patients (21%). His study highlights that delay in diagnosis and surgical referral together with iatrogenic injuries are associated with a poor outcome and successful litigation.

Conclusions

An understanding of cauda equina syndrome, its possible complications and associated medicolegal issues are important to all doctors who manage patients with spinal disorders. These include not only orthopaedic surgeons and neurosurgeons but also frontline clinicians such as emergency department staff and GPs. The diagnosis of cauda equina syndrome is suspected based on a thorough history and accurate clinical examination, and confirmed by radiological investigation, of which magnetic resonance imaging is the gold standard modality. Early diagnosis, early referral and emergency surgical decompression as soon as practically possible (within 24 hours of symptom onset) are crucial for a favourable outcome in both incomplete cauda equina syndrome and all but the most delayed cases of cauda equina syndrome with retention. Non-specialist clinicians, who may encounter patients with suspected cauda equina syndrome, should be aware of the high risk of litigation surrounding the condition and its potential contributory factors. BJHM

Conflict of interest: none.

KEY POINTS

- Cauda equina syndrome is a clinical emergency characterized by acute impairment of bladder, bowel or sexual function, and 'saddle' numbness. It is divided into two categories: cauda equina syndrome with retention in which there is established urinary retention; and incomplete cauda equina syndrome in which there is reduced urinary sensation or loss of desire to void but no established retention.
- Cauda equina syndrome is rare, occurring in 0.04% of all patients presenting with a primary complaint of lower back pain.
- Cauda equina syndrome is caused by compression of the cauda equina from a variety of causes, most commonly a herniated lumbar disc at L4/5 or L5/S1.
- The gold standard investigation for cauda equina syndrome is magnetic resonance imaging. Treatment involves surgical decompression, for example discectomy at the level of the herniated disc.
- Surgery for incomplete cauda equina syndrome should occur immediately to increase the chance of a favourable outcome. Patients with cauda equina syndrome with retention should be considered for emergency surgery as soon as practically possible in all but the most delayed of cases.
- There is a high medicolegal burden surrounding cauda equina syndrome, with approximately 10% of annual cases involving litigation. Litigation centres on delay in diagnosis and surgical referral.

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