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REVIEW ARTICLE

Cauda equina syndrome—the questions

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Abstract
Cauda equina syndrome is a devastating condition often following an innocent pathology in the form of a disc prolapse. The effect on sufferers, however, can be lifelong. It is necessary to make a diagnosis as expeditiously as possible via adequate history, clinical examination and appropriate imaging to offer treatment, in the form of decompressive surgery within 48 hours. It is extremely important to communicate adequately with the patient and their family recording all the relevant details including those of expected outcome. National guidelines are likely to be of value to clinicians and patients.

Keywords Cauda equina syndrome · MRI scanning · Disc prolapse · Medico-legal · Saddle anaesthesia · Bladder function

What is the cauda equina?

In 1595, the French anatomist Andre du Laurens first described the structure of a rope-like tail of fibres at the distal end of the spinal cord. This bundle of numerous axons was named the cauda equina, from the Latin translation meaning 'horse's tail', and it contains nerves which innervate both sensory and motor targets within lumbar, sacral and coccygeal spinal cord levels. These include the legs, perineum, anus and bladder.

What is cauda equina syndrome?

Cauda equina syndrome is a constellation of symptoms that arise due to impairment of the function of the cauda equina. This is a rare condition most commonly associated with a massive lumbar disc prolapse. Cauda equina syndrome is divided into CES-I, Cauda Equina Incomplete or CES-R, Cauda Equina Retention. These two varieties are divided by the effect on the bladder, CES-I having urinary problems with reduced bladder sensation and difficulty voiding, sometimes relying on external pressure. The other features of cauda equina syndrome such as sciatica, lower limb weakness and saddle anaesthesia are usually present. Whereas CES-R has developed to a stage where there is now complete urinary retention and overflow incontinence. The other features of cauda equina syndrome are also present although saddle anaesthesia is likely to be more dense. Two further categories have been proposed, namely CESS, cauda equina suspected and CESC, cauda equina complete [1, 2]. These can be helpful in terms of entering a treatment pathway and in suspected cases in the urgency of investigation. Cauda equina syndrome is therefore a condition affecting the legs either unilaterally or bilaterally with symptoms of back pain but importantly symptoms of recent onset of bladder function disturbance. Disturbance of bowel function may also be noticed.

What are the causes?

The most common cause is a massive lumbar disc herniation. One to 3% of lumbar disc herniations result in cauda equina syndrome, and its prevalence is one case per 33,000 to one case per 100,000 [1, 3]. It results in between 2 and 6% of disc operations or 4 and 7% [2–4]. That said not every massive disc prolapse leads to cauda equina syndrome as pointed out by Cribb et al. in 2007. They noted 15 patients with massive disc prolapses treated non-operatively; 14 showed dramatic resolution after 24 months, and no patient developed cauda equina syndrome [5]. Cauda equina syndrome can occur after surgery and was responsible for 15% of cases in one study [6]. That amounts to an incidence of between 0 and 6.6% depending upon the centre. The associated problems noted were the use of Kerrison's rongeurs as opposed to high-speed drills and the

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potential of venous congestion triggered by post-operative oedema. It is therefore very important to monitor the neurological status of post spinal surgery patients very closely, and this monitoring should be recorded. Investigations immediately after open surgery are notoriously difficult to interpret, and advice is likely to be necessary from the local imaging department. Any pathology compressing the cauda equina can cause the syndrome. Rarer causes would therefore be related to trauma and spinal fractures, tumour or infection resulting in abscess formation.

What are the symptoms?

Patients present with a number/constellation of symptoms which include low back pain, unilateral or bilateral sciatica, reduced sensation in the saddle area, reduction of sexual function, faecal incontinence, bladder dysfunction and lower limb weakness [1]. The onset of such symptoms can be slow and the actual onset difficult to pin down. Sciatica is a common complaint but in concert with reduced saddle area sensation, and interference with bladder function becomes more significant. The onset of perineal problems with bladder function problems is commonly regarded as being the onset of cauda equina syndrome and the time the clock starts ticking. Clinical suspicion needs to be acted upon urgently.

Red flags?

These are symptoms used by primary health practitioners to determine whether there is serious pathology which requires onward referral for investigation and treatment. In regard to cauda equina syndrome, these rely on the presence of bilateral radicular symptoms, with or without bladder problems. These are very non-specific, and care needs to be taken in evaluation as bilateral leg pain not descending below the knee may simply be referred pain rather than true sciatica. Furthermore, cauda equina syndrome can occur with unilateral sciatica. If there is no bladder involvement or loss of perineal sensation, then the patient could be regarded as 'being at risk' of cauda equina syndrome although currently not suffering from it. Problems with micturition could be due to pain inhibition rather than to cauda equina syndrome. Examination would not show accompanying sensory loss [7]. A paper by Verhagen et al. commented upon red flags and the variance amongst countries in their description for various spinal conditions. There was broad agreement in saddle anaesthesia and sudden onset of bladder dysfunction in nine guidelines; in all, there were nine red flags in relation to cauda equina although only the French guidelines mentioned sciatica [8].

What can be comorbidities?

Venkatesan et al. in 2012 asked if obesity was linked to cauda equina syndrome. They noted an increase in BMI was indeed linked, postulating a link between the size of disc herniation and BMI with reduced canal size, electrochemical behaviour changes, and inflammatory mediators [9]. This is confirmed by Cushnie et al. in 2018 who noted that there is an association between obesity and cauda equina syndrome due to the potential narrowing of the spinal canal due to spinal epidural lipomatosis [10].

What history is required?

A complete history of symptoms is very important. This must include a history of the onset of symptoms with particular emphasis upon any history of saddle anaesthesia and bladder or bowel problems. It should be borne in mind that pain can inhibit bladder or bowel function but there should be a high index of suspicion of serious pathology if these symptoms are present. It is important, if possible, to determine when symptoms of bladder involvement occurred. It is by this that the onset of cauda equina syndrome is likely to be measured which is important in regard to both treatment and legal assessment.

What examination is necessary?

The examination itself must be thorough and includes examination of the saddle area for loss of sensation and includes a rectal examination to note the presence or absence of anal tone. Gooding et al. noted that rectal examination did not discriminate the outcome of MRI scanning. This examination cannot therefore be used to determine whether to ration an MRI scan [11]. Bell et al. noted that if it was not possible to exclude the diagnosis of cauda equina on clinical grounds, an urgent MRI scan is recommended [12]. A paper by Balasubramanian et al. concluded that saddle anaesthesia had the highest predictive value in diagnosing MRI scan–proven cauda equina compression [13].

What investigations?

The investigation of choice is an MRI scan. This will be able to determine presence or absence of cauda equina compression (Fig. 1) from causes such as disc material, tumour, haematoma, or abscess. There are those patients that are so claustrophic that have retained metal fragments or pacemakers that other methods of either performing an

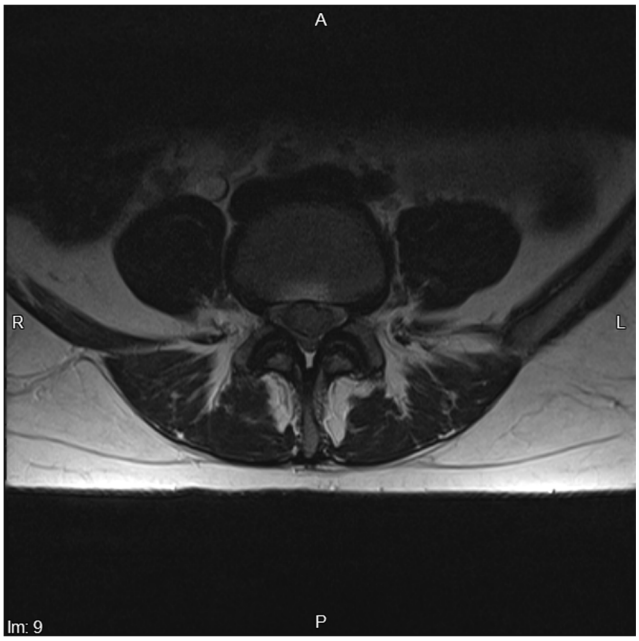

Fig. 1 Axial view showing caudal equina compression

Fig. 2 Sagittal view showing very large central disc prolapse

MRI scan or using other imaging, such as CT, is necessary. A bladder scan is also of value in determining bladder volume in suspected retention. There are those patients with clinical cauda equina syndrome that are 'scan negative'. Hoeritzauer et al. noted 61% in their study with other studies showing 43 and 48%. It was proposed that there were functional issues. The point is made that imaging was still required for all patients with possible cauda equina syndrome to exclude those in which decompression was possible [14].

Which treatment?

The treatment unless medically contraindicated is decompression of the cauda equina. This surgery needs to be extensive enough to completely decompress the cauda equina. In practice, this can be very difficult due to the stretching of the thecal sac over a massive central disc prolapse (Fig. 2). A full decompression is recommended with occasionally a trans-dural approach being required. This is not surgery for the inexperienced spinal or orthopaedic surgeon due to the potential size and position of the compressing pathology.

Timing of investigation?

The belief that early investigation and treatment offer the best outcome has been long held. That belief accepts the concept that the cauda equina is a vital structure with a blood supply. Compression can interrupt the arterial supply but more commonly the venous return. Essentially, this would lead to devitalised tissue and permanent loss of function in the territory the affected nerve supplies. The problem with the literature is the classic comparing apples and oranges as there are not enough patient details for those treated at various time frames and with all the data on the stage of their individual cauda equina syndrome. Patients are therefore treated on a case by case basis. The timing of an MRI scan is discussed in several papers. It has been proposed that such an investigation should be within one hour in a facility that has such imaging available [2]. A paper by Thangarajah et al. [15] concludes that patients with a combination of both subjective neurological findings and positive neurological signs, saddle anaesthesia, and/or decreased anal tone or sciatica had pathology on MRI which warranted surgical attention. They recommended that these features formulate the guidelines for urgent MRI. Patients without these features might not need an 'out of hours' scan. Not every unit has an 'out of hours' service. Patients presenting in these units would then have to be first on the list the following morning if not accepted for transfer to a suitable unit for investigation. Bell et al. [12] conclude that urgent MRI scanning be considered for all patients with new onset urinary symptoms in the context of lumbar back pain and sciatica. The term urgent does not have an accurate timescale. It is usually taken to mean within hours in an adequately equipped hospital to allow urgent treatment if a scan is positive. In those hospital with no 'out of hours' service if presenting outside the working day, then it should be performed first thing the next morning if no reciprocal arrangement exists for another hospital to provide a service on a' sale or return' basis if the scan is negative.

Timing of treatment?

It is also believed that the sooner decompression for a compressive lesion responsible for cauda equina syndrome is carried out the better, but that belief is hampered by poor quality studies. These studies are believed to be poor as a result of small numbers, being retrospective and with poor data and methodology. As a result, there is little hard data in regard to the timing of surgical intervention. Todd in his paper from 2015 having assessed 56 papers concludes that the longer compression of the cauda equina is allowed to continue, the poorer the outcome as it is suggested that the structural and functional neurological losses are continuously occurring [16]. A paper by Gleave and Macfarlane in 2002 had made the point that there was probably no improvement in the outcome in CES-R after 48 hours, but CES-I outcome is worsened by delay [17]. This was not supported by a paper from Thakur et al. in 2017. This used the Nationwide Inpatient Sample database from 2005 until 2011 and examined interventions at 24 hours, 24 to 48 hours, and beyond 48 hours. It is reported that delay over 48 hours of both CES-R and CES-I results in poorer outcomes. Therefore, early intervention despite the subtype of cauda equina syndrome results in improved patient outcomes [27]. Qureshi and Sell in 2007 had noted that the dominant factor in predicting the outcome of surgery was the presence of bladder function before intervention. The duration of symptoms otherwise did not appear to influence the outcome [18]. Finally, Todd in 2005 had concluded that the timing of surgery probably did influence the outcome. Meta-analysis showing that patients treated earlier than 24 hours after onset were more likely to recover bladder function than those treated after, and the same with those treated before 48 hours in comparison with those treated later [19]. These papers support the contention that the sooner surgery is performed, the more likely a positive outcome could be expected.

What outcome can be expected?

The literature confers a favourable outcome on those cases which are treated within 48 hours. Cases suffering from CES-I have a better outcome than those from CES-R [1, 20, 27]. Hussain et al. found no difference between patients undergoing urgent surgery and those operated upon the next day. This paper had small numbers, and it was noted that the onset of symptoms was variable [4]. The argument here is whether surgery in the small hours with inexperienced staff is appropriate. The timing of the onset of bladder malfunction probably remains the key factor. If the individual patient has been diagnosed and scanned quickly, a delay overnight is likely, on balance, to have less negative impact than a patient diagnosed later in the pathological process.

What is the legal position?

Due to the significant potential neurological losses, especially in relation to sexual function and bowel and bladder complications, cauda equina syndrome has an extremely high presence in the legal world. It is therefore incumbent upon clinicians who come into contact with patients suffering, or potentially suffering, from this condition to be absolutely clear in their dealings with patients. Firstly ‘safeguarding advice’ in regard to explaining cauda equina syndrome to patients must be very clear in terms of the signs and symptoms to be aware of. This advice following ‘Montgomery’ in the UK has to be in terms that the patient and/or their relatives understand. In a primary health scenario, this is likely to be to attend their local secondary facility such as an accident and emergency department. This also applies to allied practitioners such as physiotherapists, chiropractors, and osteopaths. Junior hospital doctors need to be aware of the relevant history and examination required. The consenting process must be robust with emphasis on the potential for long-term neurological loss. This advice must be recorded for the benefit of the clinician as well as the patients or their relatives [3]. A post by a British legal firm online on ‘World Radiography Day’ notes the role of MRI in cauda equina syndrome and makes the point that urgent investigation and treatment are necessary. It states that clinicians need to be pro-active in accessing scans even if they are not available in their own hospital [21]. MCrocker et al. make the point that many patients arrive in non-specialist units with no ‘out of hours’ MRI facility. They conclude that most of these should be scanned the next morning before transfer to a specialist unit with a diagnosis made. They exclude those with symptoms of less than 12 hours [22].

What guidelines exist?

Todd and Nicholas in the British Journal of Neurosurgery raise the spectre of the ‘white flag of defeat’ as it is suggested some of the ‘red flags’ are in fact those of late and irreversible cauda equina. They note 32% of these ‘red flags’ were of absent perineal sensation and urinary incontinence which is CES-R [23]. Todd and Dickson in the British Journal of Neurosurgery raised the issue of standards of care in cauda equina syndrome [2]. Finally, Hussain et al. note that despite the various statements from British spinal societies, the referral pattern had not changed and in particular the provision of out of hours MRI had not improved [24]. In 2015, the UK British Association of Spine Surgeons published ‘standards of care for suspected and confirmed compressive CES’. This followed discussions in the annual general meeting in 2012. It was hoped that this document would assist colleagues in primary and secondary care to access MRI scanning. No timings were given but the statement made that ‘nothing was to

be gained by delaying surgery and potentially much to be lost. Decompressive surgery should be undertaken at the earliest opportunity, taking into consideration the duration of the pre-existing symptoms and potential for increased morbidity while operating in the small hours. We do not consider that there is anything in the literature that justifies contravention of this principle. We recommend reasons for any delay in surgery are documented' [25]. It would be for other areas of the world to determine their own standards of care, but these are likely to be information and helpful in the complex clinical decision making required in cauda equina syndrome. Finally, Todd in 2018 has proposed a cauda equina syndrome scoring system based upon the three factors of perineal sensation, anal tone and squeeze and bladder function. This proposal is aimed at attempting to quantify the presentation of the individual patient and to aid decision making. It would appear to be a valuable addition to the discussion and would need to be thoroughly evaluated [26].

Compliance with ethical standards

Conflict of interest The author declares that he has no conflict of interest.

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