Cauda equina syndrome
a graphical representation of a time-sensitive condition

BACKGROUND

Over the years, many papers have been published examining the relationship between the onset of symptoms in cauda equina syndrome (CES) and eventual recovery following treatment. A meta-analysis published by DeLong et al[1] in 2008 distinguished between incomplete CES (CESI) and CES with urinary retention (CESR). The authors showed that the two entities behave differently, and that eventual clinical outcomes are poorer if CES progresses to the stage of CESR. In this review article, the authors were unable to demonstrate the reason for this difference on the basis of the studies they examined.

Subsequent to this review and meta-analysis, there have been some significant advancements in the understanding of clinical cauda equina, with some clinical and some animal models. In 2014, Chau et al[2] provided evidence from both human and animal studies that biological systems tend to deteriorate in a continuous rather than a stepwise fashion. They also found that, in the case of CES, the level of neurological dysfunction at the time of surgery is probably the most important determinant of eventual prognosis.

In the same year, Sun et al[3] investigated the clinical progression pattern of CES in 264 cases gleaned from the literature using a sequential pattern mining technique, and analyzed the influence of the timing of the clinical diagnosis of CES on the final clinical outcome. Sequential pattern mining showed that, in the cases reported in the literature, the progression process of CES could be divided into three stages: CES early (CESE), CESI, and CESR. Their analysis of the timing of diagnosis showed that 81% of cases were identified at the CESI and CESR stages. Of these cases, 99% had experienced CESE without being diagnosed. Sun et al[3] argued that their failure to diagnose CESE may be the leading cause of poor prognosis in CES. It then follows that clinicians should reconsider the diagnostic criteria for CES, and should not necessarily absolutely adhere to the Gleave and MacFarlane[4,5] stipulation that requires sphincter dysfunction to be present before a diagnosis of cauda equina syndrome can be made. In a guidelines proposal paper, Todd[6] cogently stated that, "Early diagnosis is of crucial importance. [...] Not all of the possible symptoms and/or signs need to be present for a clinical diagnosis of CES to be made."

A large cohort of patients operated on for CES, and reported by Srikandarajah et al[7] in 2015, provided further evidence that a biological continuum is in play as part of the pathophysiology of CES and its progression, as opposed to a strictly time-linked pathological process. The authors demonstrated that, following the onset of autonomic symptoms, the prognosis for patients in their series following surgery was time-linked, as long as the patient continued to have CESI. However, once the condition progressed to CESR, there was no eventual correlation of the outcomes of bladder dysfunction and the timing of surgery. This observation adds weight to the hypothesis that there is both a biological continuum and active process at play.

Todd[8] also describes the damage to the cauda equina nerve roots in CES as occurring in a continuous and progressive fashion, and advocated early investigation – and if needed, intervention, in cases where CES was suspected. This paper again underlines the position that CES is an active and progressive biological process with an evolving nature.

In 2015, the British Association of Spinal Surgeons (BASS) guidelines were published describing the expected professional standards in the management of CES.[9] These guidelines explicitly recognize the time-sensitive nature of CES. They also describe how symptoms of

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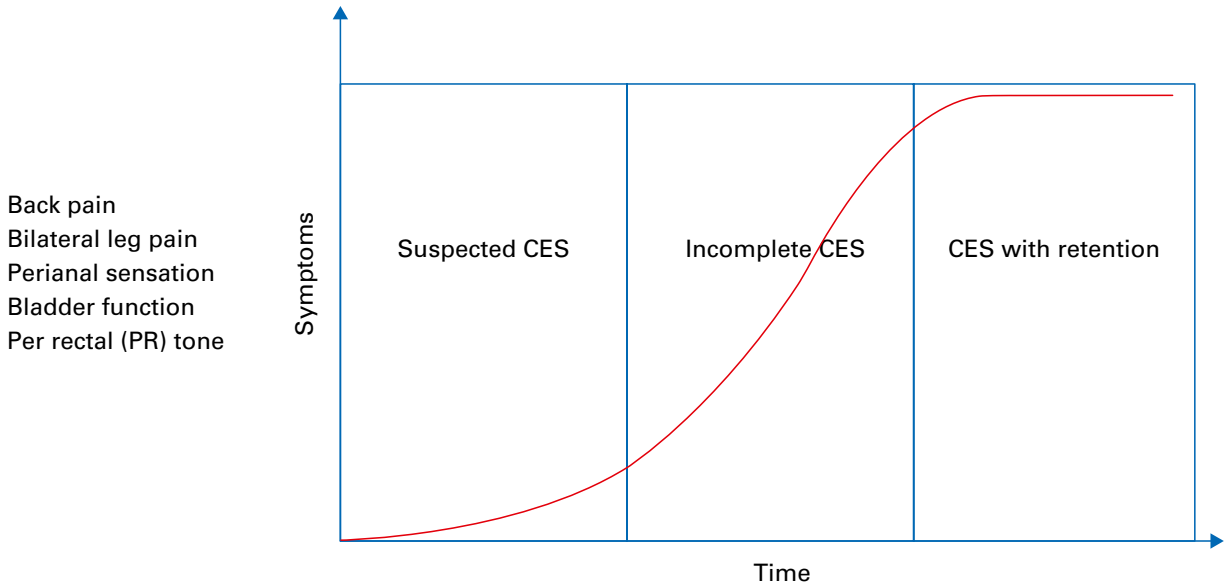

Fig. 1 Progression of cauda equina syndrome (CES) symptoms with time.

bladder and bowel dysfunction, associated with back and leg pain, should be investigated in as rapid a manner as possible with early MRI scanning and, if CES is confirmed, surgery.

Although CES is itself a rare condition, comprising only 2% to 6% of all lumbar disc herniations,[4] it has potentially devastating consequences for patients and their families, and is a significant cause of persisting neurological impairment and disability.[10] Making the diagnosis early and acting on that diagnosis is therefore essential. While there have been many published studies in the last 50 years that describe CES outcomes following surgery, it can be difficult to navigate the literature, which does not always provide a practical understanding of how to manage suspected CES (CESS). Sometimes, looking at a scenario from a graphical perspective can aid clarity. Considering the symptoms of CES against time gives a unique understanding as to how the three recognized syndromes develop. Some clinicians may find this a useful means of understanding CES.

Plotting the symptoms and signs associated with CES (back pain, bilateral leg pain, altered perianal sensation, altered bladder function, and per rectal (PR) tone) against time, for a patient evolving from CESS to CESR, shows an exponential graph until the point at which CESI becomes CESR (Fig. 1).

CES SUSPECTED

A patient presenting with bladder irritability for 24 hours associated with three weeks of lower back pain and pronounced leg pain over the lateral aspect of the shin (L5 dermatome), for example, presents with CESS. They undergo an MRI scan (the arrow in Fig. 2), which shows a lateral disc protrusion, but no compression of the cauda equina nerve roots. Their CESS is not confirmed, and with appropriate treatment for their disc protrusion, their symptoms resolve. The graph of their symptoms is therefore as in Figure 2. Full recovery of their bladder symptoms is to be expected.

CES INCOMPLETE

Compare this to a patient presenting with a three-week history of lower back pain, bilateral leg pain for one week, 12 hours of bladder irritability, and altered perianal sensation on examination. They undergo an MRI scan again expeditiously, revealing a large central disc protrusion with cauda equina compression. Incomplete CES is diagnosed (the left-hand arrow in Fig. 3). Given the MRI confirmation, surgery is undertaken rapidly (the right-hand arrow in Fig. 3). The expectation is that their symptoms will recover postoperatively. Graphically, we can plot this as shown in Figure 3. It is clear that they have been evolving along the CES pathway, but have been treated before irreversible damage has occurred.

CES WITH RETENTION

The worst-case scenario might be considered as the following: a patient who presents with a three day history of bladder leaking and bladder incontinence, 1000 ml of residual on bladder scanning, loss of perianal sensation, and a lax PR on examination. Graphically, we can represent these symptoms as shown in Figure 4. The MRI scan is performed, again as soon as possible after presentation (the left-hand arrow in Fig. 4). It shows a large central disc protrusion with significant cauda equina compression. The patient undergoes emergency surgery (the right-hand arrow in Fig. 4), but only minimal recovery in function occurs. The patient is left with a long-term bladder dysfunction.

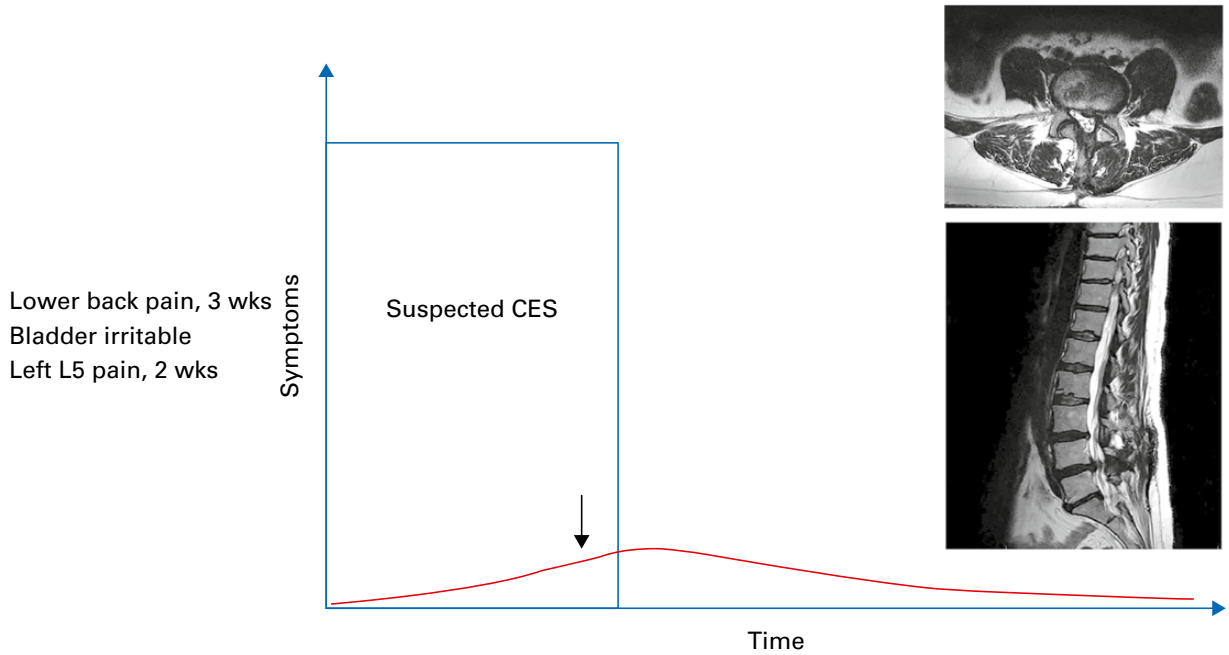

Fig. 2 Progression of cauda equina syndrome (CES) symptoms with time for a patient with suspected CES whose symptoms subsequently resolve.

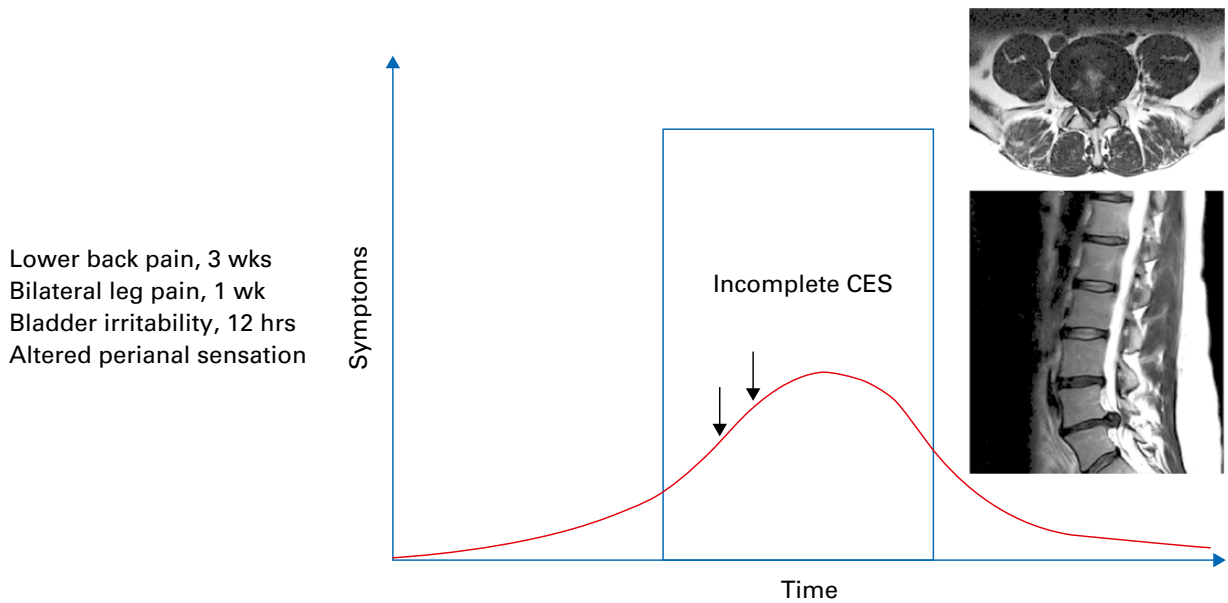

Fig. 3 Progression of cauda equina syndrome (CES) symptoms with time for a patient with incomplete CES whose symptoms recover postoperatively.

SUMMARY

Taking the graphical representations of progression in CES and its evolution shows us that three stages in the syndrome exist (Fig. 5). Patients 'pass through' CESS and CESI on their way to developing CESR. These graphs let us understand that, with appropriate treatment before irreversible changes occur, recovery is possible if surgery is performed in a timely fashion. Incomplete recovery, if any, will occur if surgery is performed too late.

The representations also demonstrate that, even with surgery, symptoms may increase after operation, but not always transiently. There are problems with this depiction, however, and these problems also help us understand the syndrome.

For any given individual, we do not know the gradient of their individual graph. The time axis is unknown, and there is little known about natural history of the condition, as many CES as described present late. Any given individual may have a steep curve, with little or no time to be lost, or they may have a lower gradient with a slower development of the syndrome. We also

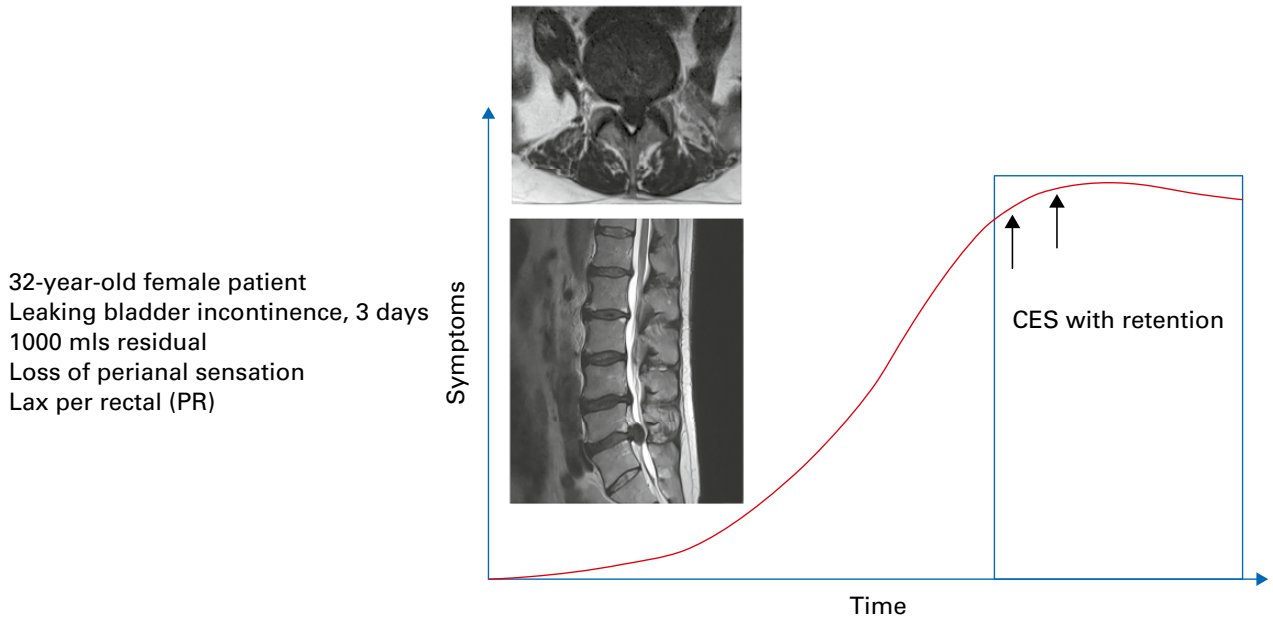

Fig. 4 Progression of cauda equina syndrome (CES) symptoms with time for a patient with CES with urinary retention.

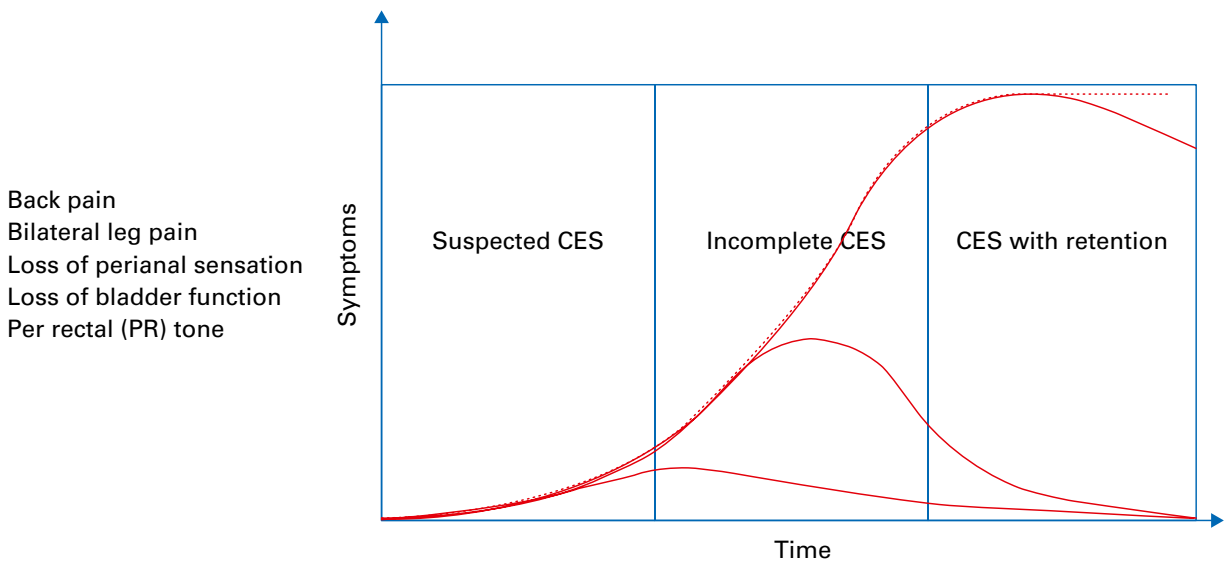

Fig. 5 Progression of cauda equina syndrome (CES) symptoms with time for patient with suspected CES, incompleted CES, and CES with urinary retention.

do not know where each individual is on their evolution graph when they present. Hence, it is vital to treat everyone expeditiously in order to maximize an individual's potential recovery. If at all possible, we must prevent CESR from developing.

Clearly, we can only investigate patients once they present to us, and these graphs help us see how the syndrome can evolve before they do so. Thinking about CES in this way with graphical depiction also shows us that we must act quickly once the patient does present. We must not be responsible for the patient moving further along their evolution graph while we procrastinate. Whenever we delay, the patient is moving up the curve and potentially heading towards a poorer outcome.

This syndrome is a time-sensitive condition, and considering it from a graphical perspective may help to make its evolution, as well as the need for urgency in diagnosis and surgery, clearer. To summarize, CES is a syndrome where a patient presents with back pain and/or leg pain, with a suggestion of a disturbance of bladder or bowel function. An MRI scan must be undertaken as an emergency. If proven, surgery should be performed at the earliest opportunity. When consenting the patient, it is important to explain to the patient that surgery may sometimes make matters worse.

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