Cauda Equina Syndrome Assessment, Diagnosis, and Management: Results from a Neurosurgical Unit from 1-year Retrospective Series—Is Our Referral System Effective?

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ABSTRACT

Cauda equina syndrome (CES) is a rare occurrence, and its clinical presentation is often vague, mimicking other neurological or medical conditions. In our service area, general practitioners (GPs) and/or the A&E Department directly refer patients to the neurosurgical service. Initial assessment is delegated to neurosurgical and radiology specialists, basing on clinical symptoms and signs. In cases where the radiological investigations come back not suggestive of true cauda equina compression, medical management of the patients' symptoms and signs can be problematic, and often delays the discharge. We performed an analysis of the whole process of assessment and treatment of patients admitted with symptoms and signs of CES. We retrospectively reviewed all the data concerning referrals and admissions for CES in our department. Both patients' clinical details and referral details were considered and critically analyzed. In 1 year examination period, a total number of 93 patients were referred to our department. Out of this number, 69 patients were admitted in the department for clinical and radiological assessment, and treatment. Eight patients required emergency surgical decompression for CES. The mean time between referral and decompression in this group was 36 hours. The average length of hospital staying was 3 days and 16 hours (40 minutes to 1 month and 10 days). We identified several areas of possible service improvement. The clinical and radiological assessments might benefit from a standardized algorithm based on all possible presentations seen in our series and reported in literature. Aiming for better timing of transports, diagnosis, and surgical treatment, as well as more rapid bed turnover in the acute ward could also increase service efficiency and reduce costs.

Keywords: Cauda equina syndrome, Cost-effective management, Diagnostic algorithms, Surgical indication.

INTRODUCTION

Cauda equina syndrome is a complex clinical entity. So debated are its characteristics and assessment that a recent study found 17 different definitions in the medical literature; the same study conducted a detailed analysis on 105 scientific papers, and concluded that for a diagnosis of CES, one or more of the following must be present: (1) Bladder and/or bowel dysfunction, (2) reduced sensation in the saddle area, and (3) sexual dysfunction, with possible neurologic deficit in the lower limb (motor/sensory loss, reflexes change).

The CES syndrome is due to intervertebral disk herniation in 45% of cases and in all of these prompt surgical decompression within 48 hours is required. In many instances, however, false-positive cases are investigated for suspicion of CES due to acute disk herniation. A number of complicating factors may explain why patients are wrongly diagnosed with CES—previous surgeries, associated medical conditions (such as preexisting urological/gynecological dysfunction), functional symptoms, etc. These can all complicate the clinical picture and result in the poor predictive value of clinical assessment alone for the diagnosis of CES. Consequently, it is recommended that any patient strongly suspected to have CES undergo emergency magnetic resonance imaging (MRI) scanning.5

Referral systems to neurosurgery services for CES vary from one country to another and even across different units in the United Kingdom. The National Health Service (NHS) Grampian referral system for CES is based on direct referral from other specialists or GPs to our neurosurgery service. Most frequently, patients are referred directly to the neurosurgeons when there is early clinical suspicion of CES, usually...
without radiological investigations. The neurosurgical team themselves review referred patients for a second clinical assessment, if considered appropriate, and subsequently liaise with neuroradiology to instigate further investigations. If indicated, emergency decompression is undertaken. Alternatively, one of two scenarios occurs: (1) Symptoms are managed with medical treatment alone and patient is discharged back to GPs/referring specialist’s care, or (2) the patient is admitted to achieve better symptom control and/or to carry out further tests to investigate other causes to explain their symptoms.

The aim of this analysis was to evaluate retrospectively the CES referral pathway in our university teaching hospital and identify possible areas for improvement.

MATERIALS AND METHODS

Referral Center and the On-call System

The Aberdeen Royal Infirmary is a 900-bed university teaching hospital in the Northeast of Scotland and is the largest hospital in the NHS Grampian Health Board. The hospital serves an immediate population of a half-million people living in Grampian, but also provides certain specialist services to a much wider geographical area, which includes the Scottish health boards: NHS Highland, Western Isles, and Orkney and Shetland (Graph 1). The overall population covered by the NHS Grampian neurosurgical service is of 800,000.

The on-call service for spinal diseases is based on five consultant neurosurgeons and two orthopedic surgeons, who cover spinal referrals on respective weeks. The rotation of the orthopedic and neurosurgical team is random throughout the year.

The neurosurgical team referral systems uses an on-call database where the following details of the referrals are reported: Date and time of referral, demographic data of the patient, clinical presentation, contact details of referring specialist/GP, physical examination findings, previous medical history, clinical suspicion, and final plan. The doctor on-call enters all the mentioned data into the database at the time of the referral itself or shortly afterward. All admitted patients are recorded into the hospital patient management system, Trackcare©, reporting details about time of admission, time of laboratory and radiological exams, laboratory and radiology results, and time of discharge. The actual images and reports of radiological investigations are accessible through the PACS Carestream© system, which shows radiological images from local and Scottish national hosts domains.

Data Collection

All the patients with clinical suspicion of CES referred to the neurosurgical service were collected over a 1-year period from the on-call database. This was from October 1, 2013 to March 22, 2015, and, in total, included 52 weeks of neurosurgical spinal referrals and not the weeks of orthopedic team on-call cover.

Only patients referred by GP/other specialist with suspicion of CES were included, while those referred for acute sciatica and/or acute episodes of low back pain (LBP) were not. Data were taken from the on-call database, from Trackcare©, and from PACS Carestream©. For the purpose of this analysis, the following groups of data were collected:

- Patients’ details: Age, clinical history, previous history of trauma and/or lumbar surgery, neurological findings at physical examination, findings at the radiological investigations, details of surgical decompression if done, final diagnosis.
- Referral details: Date and time of the referral, date and time of hospital admission/neurosurgical assessment if done, date and time of MRI scan if done, date and time of surgical decompression if done, date and time of hospital discharge.

Data were reviewed to extract the following: Timing between referral and neurosurgical assessment, radiological investigation (MRI scan), surgical decompression (if performed), and hospital discharge date. The overall outcome was critically analyzed to identify those areas with scope for improvement and suggest possible modifications to achieve more efficient and cost-effective service.

RESULTS

Totally, 93 patients were referred due to clinical suspicion of CES during the 52-week study period. About 62 patients were referred by GPs, while other specialists referred 31 patients.

Symptoms and signs at presentation are reported in Table 1. Radiculopathy was the most common symptom,
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reported by 70 patients (75%). In this group, we included patients reporting radiculopathy either as radicular pain, paraesthesia/anesthesia, or motor deficit. Other common presentations included saddle/perianal paraesthesia/anesthesia (57 patients, 61%) and LBP (55%). On physical examination, 46% of patients demonstrated objective findings of radiculopathy and 42% of patients had either altered saddle sensation or anal tone.

Totally, 69 patients overall were admitted to the hospital. Seven cases were excluded owing to noncompliant data in the electronic system. The remaining 62 cases were considered. The average time between referral and hospital admission was 1 day and 19 hours (Graph 1).

Lumbar spine MRI scan data were obtained in all but eight patients. Out of this group, seven cases were considered as not suggestive of CES by the assessing surgeon and one refused the investigation. Only 9 patients were referred after the MRI scan was done, while the remaining 76 patients underwent scanning after a neurosurgical clinical assessment. None of the patients referred after the MRI scan had disk herniation causing CES. The average interval between the date and time of the referral and MRI scan was 3 days and 30 minutes (25 minutes to 31 days; Graph 2). None of the cases having delayed MRI scanning demonstrated clinical and radiological signs of acute CES.

About 20 patients in this series were treated with surgical intervention. Among these, 8 (9.7%) required emergency surgical decompression having been identified as proven CES due to intervertebral disk herniation. All patients were treated with bilateral interlaminar decompression or wide bilateral laminectomy with partial removal of the spinous process and ligament, depending on the preference of the operating surgeon.

All but one of those patients who underwent surgery showed postoperative clinical improvement. The mean time interval between referral and surgical decompression in patients with proven CES was 34 hours (8 hours to 4 days and 6 hours). The time interval data were skewed by a long delay to surgery in one patient, who had CES promptly diagnosed, but the referring center was in one of the Scottish islands geographically distant from our center, where emergency transfer to our service was delayed by 4 days due to adverse weather conditions. Excluding this outlier, average time between referral and surgery was 25 hours (8–46 hours).

The remaining 11 patients treated with surgery were operated in elective or semi-elective conditions. These patients had either acute disk herniation causing pain-related symptoms (but not radiological signs of true CES) or chronic spinal stenosis. None of these patients reported permanent neurological disability after the surgery.

The average hospital admission length was 3 days and 16 hours (40 minutes to 1 month and 10 days). Forty-eight patients (71%) remained in the hospital for no more than 5 days, 16 patients (24%) had a hospital stay between 6 and 15 days, and 3 patients (4.4%) were admitted for more than 20 days (Graph 3).

DISCUSSION

Cauda equina is a complex clinical syndrome and its diagnosis is heavily debated in literature as well as in

Table 1: Signs and symptoms from our series

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>No. of patients</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>LBP</td>
<td>52</td>
<td>55</td>
</tr>
<tr>
<td>Radiculopathy</td>
<td>70</td>
<td>75</td>
</tr>
<tr>
<td>Pain</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>Paraesthesia/anesthesia</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Motor deficit</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>Saddle anesthesia/paraesthesia</td>
<td>57</td>
<td>61</td>
</tr>
<tr>
<td>Urinary incontinence</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Fecal incontinence</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Urinary retention</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Constipation</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Sexual dysfunction</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Altered saddle sensation</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>Altered anal sphincter tone</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Altered saddle sensation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>on pin/prick test</td>
<td></td>
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<tr>
<td>Radiculopathy</td>
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<tr>
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<td>on pin/prick test</td>
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Graph 2: Interval between referral and actual time of MRI scan. As seen, values are far less homogeneous than the previous one. This variability is explained by the different clinical pictures and judgments of referring and assessing doctors. X = patient’s number; Y = interval expressed in date and hours (e.g., 0/1/00 00:00 = no interval; 20/1/00 00:00 = 20 days of interval)
clinical practice. This analysis was designed to facilitate improvements in the assessment, diagnosis, and management of patients with suspicion of CES. We noticed from the available literature that different reports, series, and personal experiences could influence the way the patient is assessed and treated.

Our attention was mainly focused on time the patients spent throughout their entire hospital course, particularly the critical steps, and the possible methodological flaws where there is scope for improvements. We summarize our discussion as follows: (1) Referral system/clinical assessment; (2) radiological assessment; (3) surgical management; (4) hospital permanence. Notably, all these steps are closely interconnected and influence each other and the final outcome.

Referral System and Clinical Assessment

We identified few intrinsic limitations of the assessment process, as well as some that could benefit from action, with possible margins of improvement.

The first area with potential for improvement regards the doctor receiving the referral. Due to staffing constraints, in Aberdeen Royal Infirmary, the on-call rota is shared between neurosurgery trainees, neurology trainees, and junior doctors. As a consequence, the doctor on-call may lack confidence with the pertinent symptoms and signs or underestimate an atypical presentation of CES. For this reason, there is always a neurosurgical consultant as second on-call to provide expert support. We did not identify delays in assessment or diagnosis in our series of the cases considered. Nevertheless, one aspect of the referral pathway that could be changed is the inclusion only of neurosurgical trainees on the on-call rota.

A second area for change surrounds the clinical assessment itself. This is not a problem specific to our neurosurgical unit and is widely reported in neurosurgical practice and extremely debated. The positive predictive value of signs and symptoms in CES is poor, and these symptoms are affected by a number of subjective factors. As highlighted by Fraser and colleagues, the debate about what the real “red flags” in CES really are is open and there is neither unanimity (100%) nor consensus (75–99%) about it.\(^1\) Their study critically analyzed all series and reviews based on their definitions of “red flags” and how important those are considered. Despite the lack of consensus, the sphincter and saddle area involvement is homogeneously considered as the main feature of CES. Specifically, bladder dysfunction (either as retention or incontinence), saddle anesthesia/altered sensation, and reduced anal tone are reported as the main concerning signs, and the suggestion given by the authors is to consider those as “red flags.” Another review pointed out how urinary/bowel disturbances and sexual dysfunction also show poor recovery in half of the patients with positive CES, despite early surgical decompression, thus further highlighting how concerning similar presentations are.\(^2\) Leg weakness, bowel constipation/incontinence, sexual dysfunction, severe back/radicular pain (especially bilateral), and decreased reflexes are also considered important warning signs, although the context in which they present has to be taken into account, as they might be misleading when taken alone.\(^1\)

As expected, our series confirmed the results reported in the international literature. Out of 93 patients, 57 (61%) presented with saddle anesthesia, 44 (43%) reported urinary symptoms, and 19 (20%) had reduced anal tone on physical examination. By contrast, even the negative predictive value does not appear reliable, as many symptoms and signs are not found or reported in patients with “true” CES. In our series, of the eight patients with positive radiological finding who underwent surgical decompression for CES, six had urinary disturbances, six had impaired sensation in the saddle area, and three had reduced or absent anal tone. Two of them did not present with any urological or sphincter symptom, having only altered sensation in the saddle area and sciatica in one case, and only altered saddle sensation in another case. This has been highlighted as a relatively common “atypical” presentation of CES, when patient shows large L5–S1 central disk on the scan, causing mostly saddle area impairment with no serious compression on the nerves exiting from the foramen.\(^8\)

In summary, there is no conclusive means to predict how the symptoms/signs suggestive of CES are related to different causes or should be considered as red flags for CES. This brings nonexperienced doctors either to

Graph 3: Length of admissions. Most of the patients (71%) were discharged within 5 days, but a significant minority of them had longer hospital permanence. X = patient’s number; Y = length expressed in days
underestimate an otherwise concerning clinical picture, or to ask for an excessive numbers of tests in order to avoid potential litigation related to missed diagnoses.

To remedy this problem would ideally be to establish a standardized protocol for clinical assessment of CES. For example, a scoring system could be assigned to each symptom and sign, and the overall count would result in an estimated risk, which would help in establish how likely the clinical diagnosis of CES is and how urgently radiological investigations and treatment should be pursued. National guidelines based on literature evidence would be of great value. We retrospectively analyzed all cases treated in our hospital and devised a potential clinical algorithm for patient assessment to enable easier identification of those requiring scan (Flow Charts 1 and 2). This could be based on further discussions and improvements in order to implement its predictive value and efficacy.

**Radiological Assessment**

Every patient referred with suspected CES was discussed with the on-call neuroradiologist whenever a scan was considered appropriate. In order to avoid useless investigations and waste limited resources, the neuroradiology team members were always careful not to approve an MRI scan without a specialist neurosurgeon or at least senior trainee reviewing the patient, either the patient being in our Trust or in another hospital at the time of the referral. Despite patients with “true” CES being accepted and treated as quickly as possible, we still noticed significant delays in acquiring MRI scans in a timely manner.

The average timing between the referral and the scan was 3 days, which is beyond the acceptable timing when surgical decompression is considered effective. Three of the patients with proven CES also experienced significant delays in undergoing MRI scanning (18 hours, 19 hours, and 21 hours respectively), and this issue could have dramatically affected the final outcome. We identified three main causes for this problem: (1) Logistic (patients being referred from a distant location, with difficulties in transport); (2) hospital assessment team delayed assessment; or (3) MRI scan delayed. Regarding the first point, Scotland’s specific geography at times does not permit prompt referrals and transfer. The emergency transport system benefits from rapid ambulance and helicopter transport, but this is not always available for reasons out of our control (such as adverse weather conditions). The second point should be further investigated through future analyses, as often we found it to be related to inexperienced assessing doctor, who could either underestimate patient’s symptoms or the urgency to act based on those symptoms. An established and agreed protocol for CES identifying those “red flag” symptoms requiring prompt action and scan request may also benefit from this. The third and last point has been influenced by a number of factors, including lack of MRI scan in the referring center, multiple patients requiring an emergency MRI scan, difficulties for other specialists/GPs to

**Flow Chart 1:** Clinical algorithm for patients with suspicion of CES, part 1. Patients showing/reporting two or more symptoms/signs should have an emergency MRI scan. Patients falling into the reported exceptions should be investigated for other possible clinical explanations of their symptoms, as we found that these presentations are “atypical” for CES. However, investigations should NOT delay the MRI scan, if no other sources of symptoms are found. A defined number of hours (3–4 could be a proposal) should be established as a target for no further scan delays.
organize an emergency MRI scan, and reluctance of the radiology team to scan patients showing unclear clinical presentation and history without a specialist review.

At the expense of causing controversy, it is our impression that there is not necessarily always a requirement for a specialist neurosurgery review for each patient referred due to suspicion of CES. A physical examination often turns out to be misleading, regardless of who is performing it and, whenever the assessing doctor is aware of the concerning “red flags,” the outcome of the assessment is the same: The patient requires an MRI scan. Once again, a standardized protocol for assessment of patients with suspected CES is desirable (Graph 1).

**Surgical Treatment**

Surgical management was undertaken as soon as possible and we did not experience any significant delay in surgical treatment of the patients of our series, with one exception. In this case, due to adverse weather conditions, the patient had to wait two days before being transferred to our center, and his outcome was unfortunately poor. Delays related with transfer are someway inherent in a widespread territory where centers are concentrated in a specific region and transport is not always available or feasible, like in this specific case.

In the remaining cases, the decompression was always performed within 48 hours from the referral, and below 24 hours whenever possible, as suggested by international literature. In four cases, decompression was carried out after 1 day and some hours (22, 21, 10, and 5 hours respectively) from the referral. We did not manage to collect homogeneous data regarding the causes of surgical delay, but in two of the four cases, these were related to unavailability of the theater staff due to concurrent emergencies to prioritize. In one case, the patient was delayed due to suspected cardiac disease, which needed further investigations.

Points to act on to avoid delays in surgical treatment would be: (1) acting on emergency transfer service when possible; (2) act on proper theater scheduling in order to avoid delays in urgent cases.

**Hospital Permanence**

This is perhaps the most critical point of all our findings and the one that in our experience needs to increase collective efforts including from referring doctors, the assessing and caring team, and the hospital management as well as catchment area management.

As reported in our results, 69 patients overall were admitted in the hospital, but due to a lack of data in some cases, we considered 62 in total. The average hospital admission length was 3 days and 16 hours (40 minutes to 1 month and 10 days). Most of these patients (71%) remained in the hospital for no more than 5 days, 24% of them had a hospital stay between 6 and 15 days, and 3 patients (4.4%) were admitted for more than 20 days.
Opinions surrounding these data are controversial. While it could be argued that the majority of patients were admitted, treated, and discharged within an acceptable amount of time, it is also not acceptable for an acute neurosurgical bed to be occupied by patients affected by nonsurgical pathologies for an extended period. Unquestionably, these patients experience a seriously debilitating condition, and, even if the MRI scan does not show surgical target, they do need continuous pain team, physiotherapy, and sometimes psychological assistance in order to manage the acute pain episode. It is often challenging to discharge these patients from hospital due to the lack of subacute or long-term treatment services/ward.

According to the last Reference Costs report from 2014, the average cost of a bed in the United Kingdom is approximately £600 per day. This rises up to £950 when it comes to acute surgical and medical services, with an average overall admission cost of £3,688. It is easy to imagine how heavily these costs impact on the NHS health care system. As reported before in all previous passages, patients are referred and admitted in a neurosurgical ward for investigations. Only a minority of them (8%) had a proven diagnosis of CES. However, many of those with a negative MRI scan (30%) were admitted for a prolonged period of time in an acute neurosurgical unit for physiotherapy and pain management. The overall concept of admitting a patient in an acute surgical ward for investigations does not appear to be cost-effective. In fact, it might be argued that only patients with proven CES should be admitted to neurosurgery, while reserving medical or rehabilitation wards for those patients with negative MRI scan who are not suitable for discharge.

The A&E Departments have a well-established 4-hour target for patients presenting with acute medical or surgical conditions; this target expects 98% of patients to be seen, treated, admitted, or discharged in under 4 hours, and it is based on evidence that outcome is improved when shortening times of admissions in A&E are obtained. It is perhaps not unreasonable to argue that a similar target with different time scale (days in most cases) should be obtained for all acute surgical and medical wards. The turnover might be increased following two main strategies:

- Limit noncompliant admissions.
- Pursue a rapid diagnosis, treatment, and postoperative care, discharging the patient as soon as the surgical pathology is considered treated.

In the specific situation of a neurosurgical service with limited bed availability, these objectives can only be achieved by reducing the number of admissions of patients who do not need surgical treatment, and by implementing long-term ward and rehabilitation institutes’ bed availability, improving packages of care at time of discharge, and/or improving home nursing/social/pain treatment services.

**Proposal of a New Diagnostic Algorithm**

Based on data reported in literature and on our personal experience, we propose a diagnostic algorithm for patients with suspected CES (Flow Chart 1). This algorithm has not been officially tested on patients; however, it is only a reflection of a retrospective analysis, and is intended as provisional and open to discussion. By following the rules reported, we believe that all patients with strong suspicion of CES could be easily diagnosed, and noncompliant admissions/scans could potentially be avoided.

**CONCLUSION**

In summary, we identified the following potential areas that need to be addressed and improved in our service provision:

- Referral system and clinical assessment—aim for uniform and expedited referral and clinical assessment in all cases. Proposed action: New protocol for patient assessment (see above).
- Radiological assessment—aim for accurate selection of MRI scans to be performed, but also for prompt scans in those who require them. Proposed action: As above, a clinical protocol that can be easily and safely used by all medical professionals (see above).
- Surgical treatment—aim for prompt surgical treatment in all patients with proven diagnosis of CES. Proposed actions: Improve emergency transfer service when possible, improve coordination with other emergencies in order to avoid logistic delays.
- Hospital permanence—aim for reduced number of nonsurgical admissions with more rapid bed turnover in a neurosurgical ward. Proposed actions: Avoid admissions of patients without a proven CES, implementation of local subacute/rehab services.

**REFERENCES**


