

# Cauda Equina Syndrome: Are final-year clinical student chiropractors and their supervisors recognising and implementing the correct referral pathways in the UK? Two case reports

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**Background:** Low back pain is a condition that is treated by chiropractors, osteopaths, and physiotherapists who use manipulation as one of their therapies. One presentation of low back pain is a disc extrusion or sequestration. Here the disc material has ruptured through the annular fibres and because of its acidic nature starts to damage the nerve root and can lead to *cauda equina syndrome* (CES). This paper explores this documented cause of CES with final year chiropractic students who are in a primary contact position. It describes whether they screen for signs and symptoms of CES and ask the appropriate questions leading to correct referral pathway. We review iatrogenic causes of CES by professionals who use manipulation, and ask does the literature support this effect? If signs and symptoms are not diagnosed, it can lead to a life-changing future for the patient and result in a legal process and an insurance claim. Professions treating low back pain must be vigilant and constantly screen for CES.

**Intervention:** Two cases presented to the *AECC University college Chiropractic (AECC UC) Teaching Clinic* are reviewed. Final-year students see patients in their placement year as part of their training. They take a detailed history and physically examine the presenting complaint. Low back pain is a common complaint presented by patients at the AECC UC Chiropractic teaching Clinic. Are Cauda Equina Syndrome (CES) questions asked during the initial consultation and treatment? The required routinely asked questions are as follows: Has the patient experienced any of or a combination of the following signs and symptoms: saddle anaesthesia, nerve root pain, sexual dysfunction, bowel disturbance, bladder disturbance and relevant medical history relating to a previously diagnosed CES?

**Outcomes:** The findings from the case reports suggest that chiropractic students supervised by registered chiropractors are good at recognising CES signs and symptoms either initially or ongoing, through a course of treatment and are following the modified NHS guidelines for referral with the AECC UC CES pathway. The literature refers to a mechanical cause of CES due to lumbar spinal manipulation. According to the current literature lumbar spinal manipulation delivered by a registered professional for low back pain is not a risk factor for CES.

**Conclusion:** Patients with low back pain may have an elevated risk of cauda equina syndrome independent of manipulative treatment which is not considered a risk factor. Therefore, students and clinicians treating lower back pain patients are ideally placed in clinical settings to identify cauda equina syndrome signs and symptoms and should always be aware of any deterioration in presentation and review CES signs and symptoms and use the appropriate clinical pathway.

**Indexing terms:** Chiropractic; Cauda equina syndrome; chiropractic adjustment; manipulation; care pathway.

## Introduction

Low back pain is common but self-limiting and responds to conservative care. (1) However, leg symptoms and any of the signs listed in Table 1 should be considered as Cauda Equina Syndrome (CES) signs and symptoms and warrant an immediate referral to an accident and emergency department. (2) According to Zusman et al (3) to qualify as a true Cauda Equina Syndrome (CES) there must be sacral nerve root compression or occlusion ranging from S2 to S5. (See Figure 1) Direct nerve root compression is often linked to lumbar disc prolapse or extrusion and can lead to disc sequestration. (4) Chiropractors, osteopaths, and physiotherapists are health professionals frequently consulted by patients with low back pain. If any signs and symptoms in Table 1 are present, spinal manipulation is considered a contraindication. (2, 5)

*... supervised students and registered Chiropractors are ideally placed to identify cauda equina syndrome signs and symptoms and enter patients into approved protocols...'*



Table 1: The signs and symptoms which can be present in cauda equina syndrome. (5,6)

Key	Signs and symptoms
Saddle anaesthesia	Loss of sensation between the legs Numbness in/around the anus and/or genitals Inability to feel toilet paper when wiping
Bladder disturbance	Inability to urinate Difficulty initiating urination Loss of sensation to stop or control urination Loss of the full bladder sensation
Bowel disturbance	Inability to stop bowel movement due to loss of anal tone Constipation Loss of sensation when having a bowel motion
Sexual problems	Inability to achieve an erection or ejaculate Loss of sensation during intercourse
Nerve root pain	Common to have a combination of back pain, leg pain, and leg numbness/weakness.
Medical history implications	Violent injury to the back, lumbar spine surgery, history of cancer, severe infection.

Tidy (7) reported that CES occurs in approximately 2% of lumbar disc herniation cases, with no reference to sequestration. According to Kapetanakis et al (2) Disc sequestration accounts for up to 45% of cases of CES, other conditions should be considered including tumours, infection, stenosis, and inflammatory and vascular causes. (2, 8, 9) Budtz et al (11) described 0.01% of serious pathologies can lead to CES. The incidence is variable and dependent on aetiology, as seen in Table 2.

Table 2: Pathologies that can lead to Cauda Equina Syndrome presented in the literature.

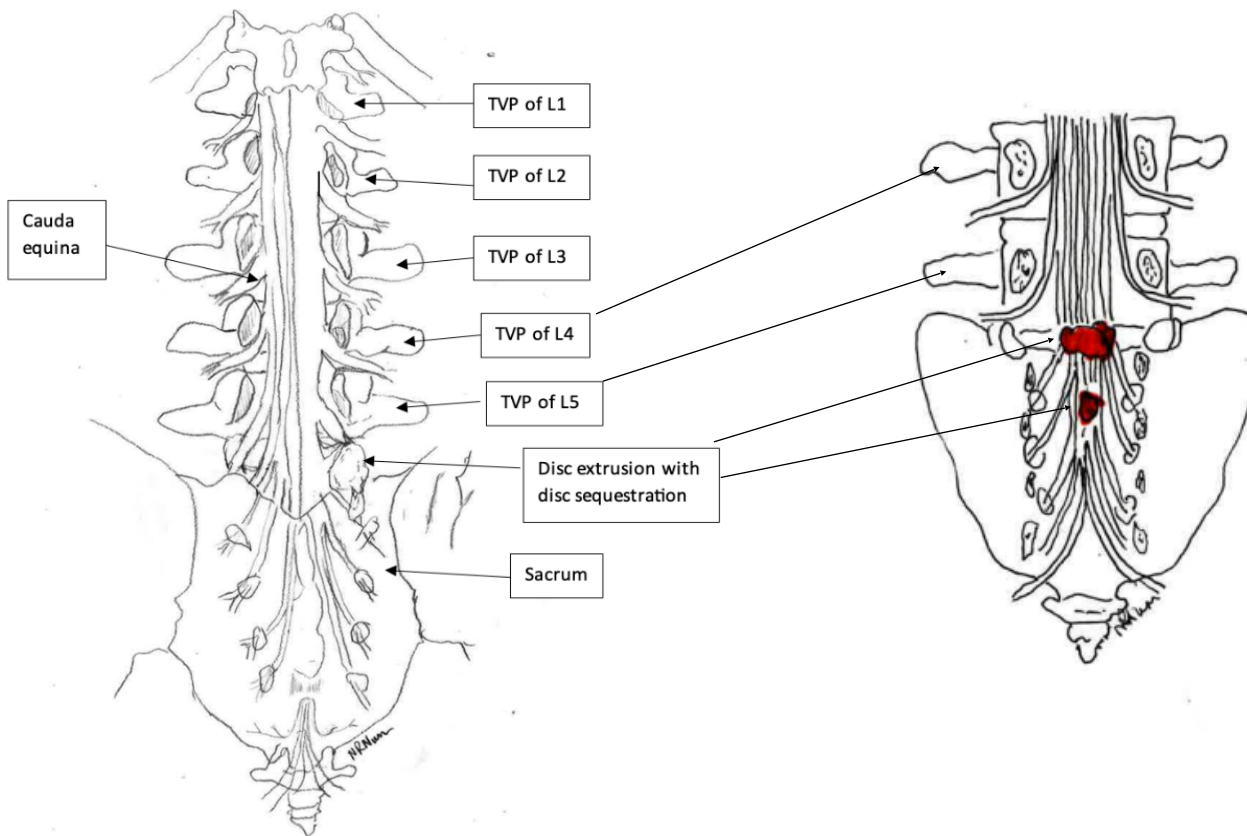
VASCULAR	Epidural, subdural hematoma, Aortic dissection, Inferior vena cava thrombosis, Arteriovenous malformation	Parke et al 1981, (8) Cordan et al 1999, (9)
INFECTION	Bacterial spinal abscess, Tuberculosis	Agarwal et al 2014, (10)
NEOPLASTIC	Ependymoma, Neurofibroma, Metastasis	Bennett et al 2015, (25)
DEGENERATIVE	Spondylolisthesis, Lumbar spinal stenosis,	Kapetanakis et al 2017, (2)
INFLAMMATORY	Ankylosing spondylosis	Tang et al 2019, (26)
IATROGENIC	Spinal manipulation, Postoperative hematoma, Radiotherapy	Tamburrelli 2011,(27)
CONGENITAL	Dwarfism, congenital spinal stenosis, kyphoscoliosis, and spina bifida	Lin et al 2022, (28)
ALLERGIES/ AUTOIMMUNE	Chronic immune sensory polyradiculopathy and Chronic immune sensorimotor polyradiculopathy.	Goodman 2018, (29)
TRAUMATIC/ THROMBOTIC	Spinal fracture or dislocation, Inferior Vena Cava Thrombosis	Hyuk Bang and Cho 2015, (30)
ENDOCRINE	Osteoporotic collapse, Paget's disease	Hadgaonkar et al 2021, (31)
SPINE	Lumbar herniated disc extruded and sequestered disc	Kapetanakis et al 2017, (2)

The prevalence of CES is estimated to be between 1 and 3 per 100,000 of the population, ranging to 270 per 100,000 with low back presentation. (12, 13,14) According to Kaiser et al (15) one of the primary presenting symptoms of CES is back pain with radicular pain in the legs, which is often the presenting complaint seen by chiropractors, osteopaths, physiotherapists, and health practitioners.

Therefore, these professions are most likely to see cases of CES due to their back pain presentations. (2, 9, 10)

Cauda Equina Syndrome has been associated with spinal manipulation in several journal articles. Spinal manipulation is one tool used in the treatment of low back pain used by chiropractors, osteopaths, and physiotherapists and is referred to as an adverse event when associated with CES. (15, 16, 17) CES is frequently misdiagnosed or is an element unrecognised because it can be progressive, causing compression of the lumbosacral nerve roots over time. (18, 19)

Fig 1: Showing the nerve roots from L1 to S5 and disc extrusion at the level of L5 S1 affecting the lower limb in neurological examination, with a sequestered disc moving down due to gravity and affect the sacral nerves S 2,3,4,5 leading to bladder, bowel, sexual and saddle sensory changes. (Drawing by author NN 2024)



Cauda Equina Syndrome is caused when the cauda equina nerve roots (S2-S5 sensory and motor nerve roots exiting the lumbar and sacrum, see Figure 1) become compressed or occluded by a space-occupying lesion, usually attributed to an extruded disc that can sequester. (5, 6) It usually presents as back pain, with leg symptoms often referred to as '*sciatica*' (unilateral < bilateral), saddle sensory changes, bladder and/or bowel dysfunction, lower limb motor and/or sensory changes and, less frequently, the inability to achieve an erection or loss of sensation during intercourse. (20, 21) (see Table 1)

CES is rare, so it is not easily diagnosed without definitive investigations. However, a detailed history with appropriate CES questions and an appropriate examination are very important. Symptoms from CES can lead to life-changing problems for the patient. There has been a drive for better recognition and referral because CES, if undetected can lead to a debilitating condition with a high medico-legal profile. (22, 23) It has been estimated that CES-related to delayed surgery has cost the NHS over the last ten years a sum of £186 million (24)(US\$245, AUD\$366, ¥ 34,773, ₱13,737).

Several authors have reported a link between lumbar spinal manipulation and CES. (32, 33, 34) Silver (35) described a case which appeared to be a case of CES from manipulation performed under anaesthetic by a medical practitioner. A systematic review by Funabashi et al (33) on adverse severe factors associated with lumbar spine manipulation for disc herniation indicated that CES is possible, (27) observed a rapid onset of CES following spinal manipulation for a herniated disc and concluded that there is a pathogenic relationship.

However, Trager et al. (34) in the most recent paper surveyed over 130,000 patients with similar demographics for low back pain through statistical matching and suggested there are no risk factors following spinal manipulative treatment undertaken by a chiropractor or physical

therapist for cauda equina syndrome, but patients with low back pain could be developing cauda equina syndrome so must remain vigilant. They concluded that these cases indicate that rather than the cause, it may be that the signs and symptoms were in fact misdiagnosed and that the CES signs were not picked up. Table 3 shows 27 peer reviewed papers linking cauda equina syndrome and those professions that used spinal manipulation from 1967.

### Literature search

A systematic search was conducted for articles in PubMed, including MEDLINE, EMBASE, CINAHL, and the Cochrane Library up to January 2024, by CG. NN performed study selection, and CG independently reviewed using the following MeSH terms: spinal manipulative therapy SMT, to include adjustment, manual therapy and manipulation linked with cauda equina from any professional engaged with SMT (chiropractic, physiotherapist, osteopath, medical practitioners). Seventy-four papers were found, and forty-seven were rejected because they were duplicated or did not involve SMT and cauda equina syndrome. A total of twenty-seven correlated with the inclusion criteria (see Appendix 1 and 2).

Table 3: Review of papers related to professionals who use manual treatment or manipulation for low back pain and a correlation to causing cauda equina syndrome.

Author	Year of publication	Journal	Title of article	Type article	Professional
Richard (36)	1967	<i>New York State Journal of Medicine</i>	Disk rupture with cauda equina syndrome after chiropractic adjustment.	Case report	Chiropractor
Hooper (37)	1973	<i>Medical Journal Australia</i>	Low back pain and manipulation. Paraparesis after treatment of low back pain by physical methods	Case report	Chiropractor
Malmivaara and Pohjola (38)	1982	<i>Lancet</i>	Cauda equina syndrome caused by chiropraxis on a patient previously free of lumbar spine symptoms	Case report	Chiropractor
Gallinaro and Cartesegna (39)	1983	<i>Lancet</i>	Three cases of lumbar disc rupture and one of cauda equina associated with spinal manipulation (chiropraxis)	Multiple Case reports	Chiropractor

Kornberg (39)	1988	<i>Surgery</i>	Lumbar artery aneurysm with acute aortic occlusion resulting from chiropractic manipulation: a case report	Case report	Chiropractor
Slater and Spenser (41)	1992	<i>Journal of the Royal Society of Medicine</i>	Central lumbar disc prolapse following chiropractic manipulation.	Case report	Chiropractor
Haldeman and Rubenstein (42)	1992	<i>Spine</i>	Cauda equina syndrome in patients undergoing manipulation of the lumbar spine	Case report	Chiropractor
Haldeman and Rubenstein (43)	1993	<i>Journal Manipulative Physiological Therapy</i>	The precipitation or aggravation of musculoskeletal pain in patients receiving spinal manipulative therapy	Case report	Chiropractor
Ryan (44)	1993	<i>Medical Journal Australia</i>	Massive disc sequestration after spinal manipulation	Case report	Chiropractor
Lee et al (45)	1995	<i>Neurology</i>	Neurologic complications following chiropractic manipulation: a survey of California neurologists.	Survey	Chiropractor
Markowitz and Dolce (46)	1997	<i>Orthopaedics</i>	Cauda equina syndrome due to sequestered chiropractic recurrent disk herniation after chiropractic manipulation	Case report	Chiropractor
Silver (35)	2001	<i>Spinal cord</i>	The earliest case of cauda equina syndrome caused by manipulation of the lumbar spine under a general anaesthetic	Case report manipulation under anaesthetic	Medical practitioner

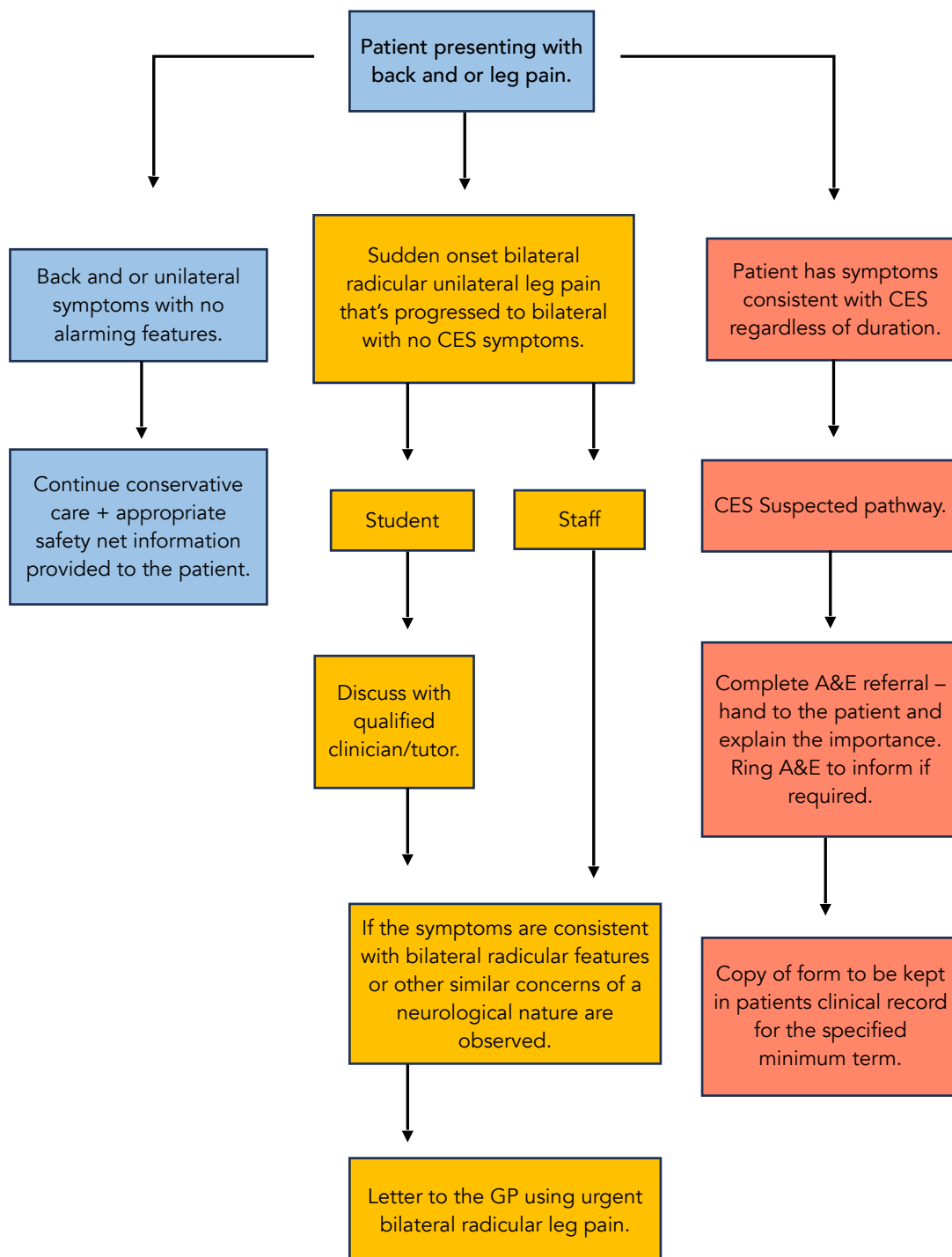
Oliphant (47)	2004	<i>Journal Manipulative Physiological Therapy</i>	Safety of spinal manipulation in the treatment of lumbar disk herniations: a systematic review and risk assessment	Systematic review	Chiropractor
Oppenheim et al (48)	2005	<i>Spine Journal</i>	Nonvascular complications following spinal manipulation	Case reports	Chiropractor
Solheim et al (49)	2007	<i>Neurosurgery</i>	Lumbar epidural hematoma after chiropractic manipulation for lower-back pain: case report	Case report	Chiropractor
Tamburrelli et al (27)	2011	<i>European Spine Journal</i>	Cauda equina syndrome and spine manipulation: case report and review of the literature.	Case report	Chiropractor
Boucher and Robidoux (50)	2014	<i>Journal Forensic Leg Medicine</i>	Lumbar disc herniation and cauda equina syndrome following spinal manipulative therapy	Case report	Chiropractor
Hebert et al (32)	2015	<i>Journal of Manipulative Physiological Therapy</i>	Serious adverse events and spinal manipulative therapy of the low back region: a systematic review of cases	systematic review	Health care provider
Undabeitia et al (51)	2016	<i>Neurocirugia (Astur)</i>	Cauda equina syndrome after chiropractic treatment.	Case report	Chiropractor
Degenhardt et al (52)	2018	<i>Journal Osteopathic Medicine</i>	Characterizing adverse events reported immediately after osteopathic manipulative treatment.	Case report	Osteopath

Yang et al. (53)	2018	<i>American Journal of Physical Medicine &amp; Rehabilitation</i>	Cauda Equina Syndrome Due to Vigorous Back Massage with Spinal Manipulation in a Patient with Pre-Existing Lumbar Disc Herniation: A Case Report	Case report	Manipulating Masseur
Rubinstein, et al. (54)	2019	<i>British Medical Journal</i>	Benefits and harms of spinal manipulative therapy for the treatment of chronic low back pain: systematic review and meta-analysis of randomised controlled trials	randomised controlled trials	Chiropractor
Budtz et al. (11)	2021	<i>Physiotherapy</i>	The prevalence of serious pathology in musculoskeletal physiotherapy patients	cohort study	Physiotherapist
Funabashi et al. (33)	2021	<i>JBI Evidence Synthesis</i>	Serious adverse events following lumbar spine mobilization or manipulation and potential associated factors: a systematic review protocol	systematic review	Chiropractor
Gianola et al. (55)	2022	<i>British Journal of Sports Medicine</i>	Effectiveness of treatments for acute and subacute mechanical non-specific low back pain: a systematic review with network meta-analysis	Meta analysis	Physiotherapist
Chu et al. (56)	2023	<i>Nature Scientific Reports</i>	A retrospective analysis of the incidence of severe adverse events among recipients of chiropractic spinal manipulative therapy.	Retrospective analysis	Chiropractor
Trager et al. (34)	2024	<i>PLOS ONE</i>	Association between chiropractic spinal manipulation and cauda equina syndrome in adults with low back pain	Retrospective cohort	Chiropractor



Chiropractors, osteopaths, and physiotherapists are professionals to whom patients can self-refer, so these professions are considered as 'primary contact practitioners', according to Jones-Harris (57) and Leech et al. (55) They are ideally placed to observe and evaluate possible CES presentations and if observed using the AECC UC modified NHS pathway (see figure 2) for refer for appropriate investigation and treatment. (NHS CES pathway, (59) the AECC UC CES SOP (60) This paper explores two cases that presented to the AECC UC Chiropractic student final year placement clinic in 2023 and 2024. It also considers the literature and the link that manipulation is an iatrogenic cause of CES.

Fig 2: Clinical pathway for CES assessment modified from AECC UC (60).



## Case Reports

### *Patient A*

Patient A is a 75-year-old female who presented June 2023 to the AECC UC chiropractic clinic. The patient, registered blind and type 2 diabetic, presented with a 48-year history of low back pain (LBP) following a spinal collapse (non-pathological compression fracture). The patient received an epidural for pain relief via the NHS. The patient became concerned when the pain suddenly worsened in the buttock. The patient reported she began experiencing tingling in the right calf and a lack of sensation in both feet. These symptoms began to radiate into the calf. At the time, the patient reported slight urinary incontinence of 12-month duration.

On examination, soft and sharp sensation showed confusion on the right in the lower limb (L5/S1), vibration sense was absent on the right and diminished on the left. Her muscle strength appeared normal in the lower limb bilaterally with lower limb patella reflexes recorded as 2+ bilaterally. Achilles reflex was 1+ bilaterally.

An initial diagnosis proposed was '*chronic lumbar sacral stenosis with associated myofascial pain*' complicated by an early diabetic neuropathy.

When the patient returned the initial student clinician was on another placement and the patient was seen by a different student clinician in July 2023 and treated three times and once in early August 2023, because the patient reported good progress in outcome measures the schedule of treatment was opened to 2-week intervals. Later in August 2023 the patient presented and reported she had been going to the toilet with increased urinary abruptness, while experiencing numbness on the inner thighs. Upon questioning the patient reported she had lost control of urinary flow rather than just an increase in urge.

A *Cauda Equina Screening* tool was completed and, as a result, she was referred to Accident & Emergency Department with a copy of the CES screening results and a *Royal College of Chiropractors* (RCC) referral letter. The patient was followed up in September 2023 and she confirmed she had Cauda Equina syndrome diagnosis following an MRI and she was expecting a consultant appointment within 2 weeks. The patient had successful spinal surgery in December 2023 and has made a full recovery with rehabilitation.

### *Patient B*

Patient B is a 72-year-old female who presented to the AECC UC chiropractic clinic in February 2024. She presented with a 3-week history of sudden mid to lower back pain after bending forward. The pain had progressed into the right anterolateral thigh and her right groin and was now constant. She described the pain as an excruciating stabbing pain in the mid to lower back. She reported she felt weak in her right hip and an inability to actively flex her right hip. She was now unable to walk safely unaided and all her activities of daily living (ADLs) walking, sitting, standing, bending had been reduced in duration and repetition. She reported that the only relief was from prescription medication.

On examination, movement was extremely limited because she was unable to walk without support and she was not able to lie prone or on her side. Palpation of her mid to lower back in a seated position showed all ranges of motion were significantly limited in flexion, extension, rotation and lateral flexion and she was hesitant due to pain. Neurological testing revealed weakness and pain in the L2-3 and L3-4 myotomes and a reduction in identifying soft and sharp dermatomes in the same areas. All Cauda equina questioning were negative. Her blood pressure was also elevated but this was thought due to the pain she was experiencing.

An x-ray was taken of the lumbar spine because the original diagnosis was thought to be a compression fracture due to osteoporosis. The images revealed significant degenerative changes with no osteoporotic changes, but a recommendation of a DEXA scan and MRI was made. The MRI

report suggested a L4-5 grade 1 anterior spondylolisthesis of L4 on L5 with mild spinal canal stenosis and no obvious compression on the Cauda equina nerve roots. A posterolateral disc protrusion/extrusion was noted at L2-3 with hypertrophy ligamentous flavum and facet joint arthropathy, causing moderate canal stenosis with crowding of cauda equina nerve roots.

A *Cauda Equina Screening* tool was completed due to the results of the MRI and, CES screening results which were borderline, and a *Royal College of Chiropractors* (RCC) CES referral letter was sent to her GP. She was informed we suspected cauda equina syndrome. She was told what to look out for and what action to take if any of those signs or symptoms arose.

A referral was made to her GP considering her MRI findings, and the recommendation of a DEXA scan and her elevated blood pressure readings. We could not rule out the possibility of cauda equina and asked for her to have a second opinion via her GP because we were unable to manage her conservatively at this stage. The patient was followed up four weeks later and eight weeks later and confirmed that, initially, she was being monitored for cauda equina syndrome, but no action had been taken.

## Discussion

Chiropractors, osteopaths and physiotherapists are ideally placed to observe and evaluate CES using the UK NHS pathway for in hours referral which has been modified at the AECC UC. (NHS CES pathway, (59) the AECC UC CES SOP (60))

Chiropractors along with the other professionals are referred to as '*primary contact practitioners*' according to Jones-Harris, (57) Leech et al, (58) and Grace et al. (61)

Greenhalgh et al. (62) stated that patients who present with back pain and radicular pain should have a detailed history of presenting complaint, family history, past medical history and medication, with specific CES questions that covers '*sciatica*' (unilateral<bilateral), saddle sensory disturbances, bladder and/or bowel dysfunction, and lower limb motor and/or sensory changes and, less frequently, the inability to achieve an erection or loss of sensation during intercourse. (15, 20, 21) If there are one or more signs or symptoms from Table 1, an urgent referral to Accident and Emergency is recommended from the NHS CES pathway. (59) According to Hussain et al (63) there are two forms: true (t-CES) and false (f-CES) cauda equina syndrome. A review of 250 referrals showed only 13% had confirmed t- CES. (63)

Kapetanakis et al (20) stated there are two critical points for a suspected CES; a detailed history with a physical examination, and second, imagining from either an MRI or CT. Once confirmed from MRI, surgery should be considered as the gold standard. According to Ahad et al (64) and Balasubramanian et al (65) an MRI should be considered because the signs and symptoms above are insufficient to identify true Cauda Equina Syndrome (CES-R or CES-C).

Lavy et al (21) identified 17 definitions of cauda equina syndrome within the literature, with two major stages, incomplete and retention. They propose several subdivisions which we give in Table 4. These include:

- ▶ Cauda Equina Syndrome with retention(CES-R) describes Cauda Equina Syndrome in a patient that has painless urine retention or overflow
- ▶ Cauda Equina Syndrome incomplete (CES-I) means altered urinary stream but maintenance of bladder control but no urinary retention and/or overflow.

There may be perianal sensation changes. Both CES-R and CES-I need immediate accident and emergency referral because if not treated, both can lead to irreversible bowel and bladder damage and dysfunction of the lower limbs. Lavy et al (21) agreed with CES-S classification from only clinical history or radiographic findings that could lead to early cauda equina (CES-E) due to the changes in bladder frequency but normal bladder, bowel and sexual function and some

sensory loss in perineum. A complete cauda equina syndrome (CES-C) is based on a history and clinical findings with a complete loss of bladder sensation and overflow incontinence, loss of perineal sensation and loss of sexual sensation.

Table 4: Comprehensive classification of cauda equina syndrome from Lavy et al (21).

Name	Abbreviation	Definition	Action
Suspected CES	CES-S	No bladder/bowel/genital/perineal symptoms, but bilateral sciatica or motor/sensory loss in legs. (This is clinical CESS)	Constant monitoring consider MRI imaging letter to GP
		Or a known large disc herniation on existing MRI (This is radiological CESS)	Constant monitoring consider MRI imaging letter to GP
Symptom-only CES (early CES)	CES-E	Normal bladder, bowel and sexual function but some sensory loss in perineum or change in micturition frequency	Constant monitoring consider MRI imaging and onward referral letter to GP
Incomplete CES	CES-I	Alteration in bladder/urethral sensation or function, but maintenance of executive bladder control. + / – perineal sensory changes, or sexual or bowel sensory or functional changes	Constant monitoring consider MRI imaging and onward referral A/ E
CES with retention	CES-R	As in CES-I but with painless bladder retention and overflow	Referral for surgical opinion A/E
Complete CES	CES-C	Insensate bladder with overflow incontinence, no perineal perianal or sexual sensation, no anal tone	Referral for surgical opinion A/E

Fairbank and Mallen (66) reported a better prognosis in CES-I than in CES-R, within two days for decompression surgery to have a reasonable reversal of symptoms.

As shown in Patient A, the presentations do not always present at the initial consultation. The presentation can appear even under care, so professionals must be vigilant and continue to review all CES questions. As soon as the patient reported she had lost control of urinary flow, rather than just an increase in urge, we followed the AECC UC CES pathway, and the patient was referred to accident and emergency with a completed referral form given to the patient. The patient also described experiencing tingling in the right calf and a lack of sensation in both feet. Her muscle strength appeared normal in the lower limb bilaterally. At the same time, reflexes were recorded as 2+ except S1, which was 1+ in the lower limb bilaterally and sensation in the lower limb (L5/S1) on the right for soft and sharp was diminished, and vibration sense was absent on the right and diminished on the left. A consideration was made for diabetic neuropathy, but it was felt that, due to the other signs and symptoms, this was needed to be seen by the medical professionals.

Our initial consideration was CES with retention or CES-R due to the urinary overflow according to Lavy et al (21) classification. It is unclear why there was such a delay from the original presentation in August 2023 to the onset of surgery in December 2023. However, Kapetanakis et al (2) and Busse et al (67) reported that there is a clear correlation with timing of

surgery after syndrome onset, with significantly poorer results if surgery is delayed more than 48 hours after onset. This accounts for the high medical and legal process of cauda equina syndrome. If surgery is not performed urgently after the onset of CES-R, the signs or symptoms may be permanent. (68, 69) All CES must be considered medical emergencies and referred to accident and emergency. The good news is that after the surgery patient A has made a full recovery with rehabilitation.

Patient B reported 3 weeks duration of idiopathic pain in her mid to lower back, radiating down into her right anterolateral thigh and her right groin. All her activities of daily living and quality of life had been reduced. Neurological testing revealed weakness in the L2-3 and L3-4 myotomes and a reduction in identifying soft and sharp dermatomes in the same areas. Cauda equina questioning was negative, prompting the initial diagnosis as a compression fracture. X-rays were taken and showed no evidence of compression fracture, thus a recommendation was made for an MRI. The MRI report showed an L4-5 grade 1 anterior spondylolisthesis of L4 with mild spinal canal stenosis and no obvious compression on the cauda equina nerves. A posterolateral disc protrusion/extrusion at L2-3 with hypertrophy ligamentous flavum and facet joint arthropathy, causing crowding of the cauda equina nerve roots at L2-3 leading to moderate stenosis which could account for the positive neurological test at the initial consultation.

Due to the lack of cauda equina syndrome features but MRI findings that indicated crowding of the cauda equina nerve roots at L2-3 and a borderline questionnaire, an urgent GP letter was drafted with our concerns, with a consideration of onward referral for a neurological consultation as we could not rule out a progression to CES-S. This is often the case and according to Comer et al (70) this is a typical presentation of older patients with lumbar stenosis. She is now being managed with constant observation for stenosis.

A review of the literature shown in table 3 demonstrates the association between spinal manipulation and cauda equina syndrome in adults with low back pain which has been documented over several decades. Most of the documentation has been in the form of case reports. There was limited evidence to suggest that manipulation in the lumbar spine caused cauda equina syndrome and evidence was too low to generate robust estimates of risk. (71) However suspected cauda equina syndrome has been identified as a contraindication to spinal manipulation. (72) The most significant risk to the patient is the failure of the practitioner to recognise the presence of cauda equina syndrome signs or symptoms and to exacerbate the problem if the person undergoes manipulation. Patients with low back pain may have an elevated risk of cauda equina syndrome independent of treatment. Trager et al (34) supported this through statistical matching and suggested there are no risk factors following spinal manipulation.

## Conclusion

These findings suggest that supervised students and registered Chiropractors are ideally placed in clinical settings to identify cauda equina syndrome signs and symptoms and follow the AECC UC modified NHS referral guidelines. (60) This was apparent in both case reports.

Spinal manipulation delivered by a registered professional is not a risk factor for cauda equina syndrome.

### *The most significant risk factor*

The most significant risk to the patient is the failure of the practitioner to recognise the presence of cauda equina syndrome signs or symptoms, especially in patients with just leg and back pain. Patients with low back pain may have an elevated risk of cauda equina syndrome independent of treatment. Therefore, clinicians treating lower back pain patients should always be aware of any deterioration in symptoms and therefore should, review CES signs and symptoms

as in Table 1, to ensure the patient is promptly referred for imaging and surgical evaluation as per the clinical pathway. (60)

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All participants provided informed consent to participate in this study. This study was approved on 07/03/2024 by the AECC UC Ethics Approval Number: SOC-0224-005

### *Competing interests*

The authors declare no potential conflicts of interest with respect to research, authorship and/or publication of this article.

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### Appendix 1

DATA BASE	SEARCH TERMS	NUMBER OF RESULTS
PubMed	((Cauda equina syndrome [MeSH Terms]) OR (Cauda equina)) OR ((Chiropractic manipulation [MeSH Terms]) OR (Osteopathic manipulation)) OR (Physiotherapy manipulation))) AND ((spinal manipulation [MeSH Terms]) OR (manual therapy))	25
Cochrane	((Cauda equina or (Cauda equina syndrome)) AND (spinal manipulation) AND ((Chiropractic manipulation [MeSH descriptor]) OR (Physiotherapy manipulation) Or (Osteopathic Manipulations) OR (Manual Therapy)))	26
CINAHL With Full Text	MH Cauda equina OR Cauda equina syndrome OR spinal manipulation AND MH Chiropractic manipulation OR Physiotherapy manipulation OR MH Osteopathic Manipulations OR Manual Therapy	23

### Appendix 2: Inclusion & Exclusion criteria

Inclusion	Exclusion
Cauda equina	Any other adverse condition
English	Any language other than English
Adults	Paediatrics/juveniles
Physical therapy/ Conservative management	Surgery
full text	Not full text

### Appendix 3: PRISMA 2009 Flow Diagram (Moher et al, 2009)

