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**Does a history of lumbar spine surgery predict radiological cauda equina compression in patients undergoing MRI for suspected cauda equina syndrome?**

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Running title: Prior spinal surgery in CES

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## **ABSTRACT**

### **Background**

The clinical symptoms and signs of CES are non specific and poorly predictive of cauda equina compression on MRI. We aimed to establish whether a history of lumbar spine surgery predicts cauda equina compression on MRI in those presenting with suspected CES.

### **Methods**

A retrospective electronic record review was undertaken of 276 patients referred with clinically suspected cauda equina syndrome who underwent a lumbosacral spine MRI. Those with a history of prior lumbar surgery were compared to those without. The likelihood of cauda equina compression was compared between the two groups.

### **Results**

78/276 (28%) patients with suspected CES had radiological compression of the cauda equina and went on to surgical decompression. 54 (20%) patients had undergone prior lumbar surgery. Patients with a history of lumbar surgery were less likely to have cauda equina compression on MRI ( $\chi^2$  -  $p=0.035$ ). 26 (9%) patients presented more than once with suspected CES. Patients with a history of lumbar surgery were more likely to re-present with suspected CES ( $\chi^2$  -  $p=0.002$ ).

### **Conclusions**

Prior lumbar surgery was associated with a higher frequency of re-presentation with clinically suspected CES but a lower frequency of radiological cauda equina compression.

Keywords: Cauda equina syndrome; disc herniation; surgical decompression; spine; pathogenesis; lumbar disc.

## **Background**

CES has an incidence of fewer than one in 100,000 per year according to some studies [Podnar 2007; Hurme et al. 1983]. However, the clinical symptoms that make up CES are common. Urinary incontinence has an estimated annual incidence rate of 6.3% in a UK population [McGrother et al. 2004], and the annual incidence of persistent lower back pain is higher still. This leads to a situation where a large number of patients undergo MRI for suspected CES but the majority of scans do not show cauda equina compression..

Series of patients referred for urgent lumbosacral MRI for suspected CES have shown lower than 40% positive rates [Bell et al. 2007; Balasubramanian et al. 2010; Rooney et al. 2009; Thangarajah et al. 2011]. Clinical assessment of any one particular sign or symptom has a poor predictive power for identifying those with cauda equina compression [Bell et al. 2007, Domen et al. 2009, Balasubramanian et al. 2010, Gooding et al. 2013].

It is estimated that 12.2% of patients who undergo lumbar microdiscectomy will undergo re-operation within 4 years [Heindel et al. 2017], and recurrence requiring revision occurred in 7.9% at 10 years in one series [Gaston and Marshall 2003]. It is possible that prior surgery makes cauda equina compression more likely [Bydon et al. 2017]. Repeat operations are associated with poorer outcomes in lumbar surgery [Osterman et al. 2003] and ongoing symptoms may make CES-like presentations more likely [Hoeritzauer et al. 2015]. No previous studies we are aware of have investigated the predictive power of a history of prior surgery.

## **Materials and methods**

A retrospective electronic record review was carried out of patients referred to the Edinburgh neurosurgery unit for urgent MRI for possible CES from August 2013 to November 2014. This study was conducted on the same population as another study [Hoeritzauer et al. 2018]. All patients met the clinical definition for CES described by Fraser et al. [Fraser et al. 2009]. Patients who had undergone lumbar prior decompressive surgery were compared to those who had not. The two groups were compared using X2 tests. Cauda equina compression was defined as previously described [Hoeritzauer et al. 2018], briefly: >75% canal stenosis or lack of CSF around the cauda equina nerve roots or the opinion of the consultant neurosurgeon that the cauda equina compressive lesion was causing the clinical symptoms and would progress to irreversible CES unless urgently surgically decompressed. Any further presentations to our unit for urgent MRI for CES were recorded.

## **Results**

### ***Characteristics of prior lumbar surgery***

During the 15 month period, 276 patients underwent urgent lumbosacral MRI for suspected CES. 7 patients had alternate neurological causes mimicking or causing sacral nerve dysfunction without cauda equina compression which were diagnosed during initial presentation – none of these had prior lumbar surgery. 78/276 (28%) had compression of the cauda equina. 72 underwent emergency decompression. The remaining 6 were conservatively managed: 2 were too high operative risk, 3 had metastatic compression and 1 had long duration of symptoms.

54/276 (20%) patients had a history of lumbar surgery prior to presentation (Figure 1). Of those, 9/54 (17%) had cauda equina compression on MRI and 45/54 (83%) did not. Of those without prior surgery, 69/222 (31%) had radiological cauda equina compression on MRI and

153/222 (69%) did not. Prior lumbar surgery was a statistically significant predictor of a lack of cauda equina compression on MRI ( $\chi^2$  -  $p=0.035$ ).

17 patients had undergone more than one lumbar surgery prior to index presentation and 3 of these had cauda equine compression (Table). Having two or more previous operations was not associated with the likelihood of cauda equina compression on MRI compared to a single previous surgery ( $\chi^2$  -  $p=0.90$ ).

The date of prior surgery ranged from 1 to 18 years before presentation for CES. 21 (39%) had prior surgery within 2 years of index CES presentation - 4 of these had cauda equina compression. Undergoing prior lumbar surgery within the last two years was not associated with cauda equina compression on MRI ( $\chi^2$  -  $p=0.75$ ).

11 patients had their prior operation for CES. This was not associated with the likelihood of cauda equina compression on MRI ( $\chi^2$  -  $p=1.00$ ) - 2 of these had cauda equina compression. The remainder of prior operations were for radiculopathy.

There were 9 patients with prior surgery and cauda equina compression on MRI. Both operations were at the same spinal level in 4. In 2 they were at adjacent levels and in 2 the levels were non-contiguous. In one patient the level of prior surgery was not available or discernable.

### ***Re-presentation***

Data on repeat presentations were available for a mean duration of 15 months (range: 1-32 months). During this period, 26/276 (9%) patients re-presented with suspected CES (Figure 2). Two of these had cauda equina compression on MRI and were decompressed. Eleven had undergone lumbar surgery prior to the index scan; none of these had cauda equina compression on MRI. Prior lumbar surgery led to a higher chance of re-presentation ( $\chi^2$  -  $p=0.002$ ). 7/276 (3%) patients re-presented twice or more. In this group, 4 had undergone previous

lumbar surgery. The 6 patients with cauda equina compression during index presentation who were not operated did not re-present.

## **Discussion**

This study suggests that patients who present with suspected CES and have undergone prior lumbar surgery are significantly less likely to have cauda equina compression on imaging than those who have not undergone prior lumbar surgery. Patients who have undergone prior lumbar surgery are also significantly more likely to present on multiple occasions with suspected cauda equina syndrome.

The rate of cauda equina compression on MRI in this study was similar to that seen in other UK series [Balasubramanian et al 2010; Gooding et al 2013]. We are not aware of any other series which document the proportion of patients with suspected CES who have undergone prior lumbar surgery. The incidence of lumbar surgery in the UK adult population was 4.7 per 10,000 in 2011- 2012 [Weir et al. 2017]. We found that 20% of patients with suspected CES had undergone prior lumbar surgery. Precise figures of CES incidence are required for accurate comparison [Woodfield et al. 2018].

Patients who have previously undergone prior lumbar surgery may be more likely to present and be investigated for CES, but less likely to have cauda equina compression on imaging for several reasons. Patients with prior lumbar surgery may be more aware of the risk of potential CES and therefore more likely to present with or be more wary of associated symptoms. Similarly, anxieties about CES in patients with prior surgery may influence referral decisions.

The decision to refer for spinal surgery has been shown to be influenced by non-surgical factors such as treatment expectations, [van Dongen et al. 2017]. One explanation is that shared psychological comorbidity risk factors could have been the primary influence on referral and



treatment decisions for initial lumbar surgery and for subsequent presentations without cauda equina compression [Hoeritzauer et al. 2015]. Alternatively, patients previously operated for cauda equina compression with bladder or bowel symptoms may have had persistent urinary, bowel and sexual dysfunction. [Korse et al. 2017]. However, in our series none of the patients reported chronic symptoms prior to their acute presentation. Another explanation is that patients may have been initially incorrectly diagnosed prior to their original lumbar decompression, and the intermitted episodic clinical symptoms may represent an alternative diagnosis.

Changes in biomechanics and local physiology post-operatively could also predispose certain patients to CES symptoms without radiological compression. One study found acute CES to occur in up to 6.6% of post-lumbar surgery patients and also suggested that it may be commoner in those with pre-existing spinal stenosis due to post-operative oedema or venous congestions [Podnar 2001].

Our study is the first to detail the predictive value of prior lumbar surgery for CES. It is limited by possible case selection effects due to retrospective data collection.

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**Ethical approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (name of institute/committee) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

This study has Caldicott approval (ref 1594).

We acknowledge that patients cannot be identified via the paper and that they have been fully anonymised.

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### **Table captions**

Table. Characteristics of prior lumbar spinal surgery in patients presenting with clinical cauda equina syndrome (CES).

## **Figure captions**

Figure 1. Division of patients presenting with clinically suspected cauda equina syndrome (?CES) by presence of prior lumbar spinal surgery and MRI scan result.

Figure 2. Flowchart of patients that re-presented with clinically suspected cauda equina syndrome (?CES) on follow-up with proportion of prior lumbar surgery shown.

	Positive MRI	Negative MRI	Total
<b>N</b>	9	45	54
<b>Number of prior surgeries</b>			
1	6 (66%)	31 (69%)	37 (69%)
2	3 (33%)	9 (20%)	12 (22%)
3	-	2 (4%)	2 (4%)
4	-	3 (7%)	3 (6%)
<b>Year of first surgery prior to index</b>			
≤2	4 (44%)	16 (36%)	21 (39%)
>2 to ≤10	2 (22%)	19 (42%)	21 (39%)
≥10	3 (33%)	7 (16%)	10 (19%)
No information	-	3 (7%)	3 (6%)
Range in years	1-18	1-14	1-18
<b>Level(s) of prior surgery</b>			
T11/12	-	1 (2%)	1 (2%)
L1/2	-	1 (2%)	1 (2%)
L2/3	1 (11%)	3 (7%)	4 (7%)
L3/4	3 (33%)	21 (47%)	24 (44%)
L4/5	5 (55%)	23 (51%)	28 (52%)
L5/S1	1 (11%)	5 (11%)	6 (11%)
No information			
<b>Level of index CES</b>			
L2/3	1 (11%)		
L3/4	3 (33%)		
L4/5	4 (44%)		
L5/S1	1 (11%)		
<b>Level of prior surgery compared to index CES</b>			
Same	4 (44%)		
Adjacent	2 (22%)		
Non-contiguous	2 (22%)		
No information	1 (11%)		



Table 1. Characteristics of prior lumbar spinal surgery in patients presenting with clinical cauda equina syndrome (CES).



