Spine

SPINE Volume 47, Number 2, pp 105–113

CLINICAL CASE SERIES

Cauda Equina Syndrome

Poor Recovery Prognosis Despite Early Treatment

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Study Design. A prospective patient's database operated on a cauda equina syndrome (CES).

Objective. The aim of our study was to identify prognosis factors for favorable functional recovery after CES.

Summary of Background Data. CES is a neurologic impairment of variable symptoms associating urinary, bowel, and sexual dysfunctions with or without motor or sensitive deficits caused by nerve root compression of the cauda equina. The definition of CES remains debated, as well as the prognosis factors for favorable functional recovery and the benefit of early surgery.

Methods. One hundred forty patients were included between January 2010 and 2019. Univariate and multivariate cox proportional hazard regression models were conducted.

Results. The patients were young with a median age of 46.8 years (range 18–86 yrs). At presentation, 60% were affected by a motor deficit, 42.8% a sensitive deficit, 70% urinary dysfunctions, and 44% bowel dysfunctions. The mean follow-up was 15.5 months. Bilateral motor deficit ($P = 0.017$) and an initial deficit severity of 0 to 2 ($P = 0.001$) represented prognosis factors of poor motor recovery. Initial anal incontinence ($P = 0.007$) was associated with poor bowel recovery. Only 32.8% of the patients went back to work. Initial motor deficit ($P = 0.015$), motor sequelae ($P = 0.001$), sphincter dysfunctions sequelae ($P = 0.02$), and long LOS ($P = 0.02$) were poor return-to-work prognosis factors. Time to surgery within an early timing < 24 or 48 hours or later did not represent a prognosis factor of recovery in CES. Incomplete *versus* complete CES did not show better recovery.

Conclusion. CES remains a profound disabling syndrome with poor functional prognosis: in the long run, few patients go back to work. The main prognosis factors established in our series regarded the initial severity of deficits whether motor or sphincteral. Early or later surgical cauda equina decompression did not show to represent a prognosis factor for functional recovery.

Key words: bowel, cauda equina, disabling, disc herniated, functional prognosis, motor deficit, surgery, urinary.

Level of Evidence: 4

Spine 2022;47:105–113

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Acknowledgment date: October 22, 2020. First revision date: December 20, 2020. Acceptance date: May 19, 2021.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No funds were received in support of this work.

No relevant financial activities outside the submitted work.

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DOI: 10.1097/BRS.0000000000004170

Cauda equina syndrome (CES) is a neurologic impairment caused by the compression of nerve roots of the cauda equina.[1] CES is a rare compression, representing approximately one or two per 100,000.[2,3] Herniated lumbar disc is the most common etiology[4] and occurs in 1% to 10% of cases.[5–7]

An exact definition of the cauda equina syndrome remains unclear. In 1934, Mixter and Barr[8] were the first to describe symptoms of numbness, tingling, anesthesia, loss of power of locomotion, and bladder/rectal sphincter disorders, in a context of rupture of the intervertebral disc.

Later, in 1959, Shephard[9] defined cauda equina syndrome as a weakness of muscles below the knees, impairment of skin sensation in the saddle area, micturition difficulties, and radiating symptoms.

In 2002, Gleave and Macfarlane[10] defined two subtypes of CES: 1) incomplete-CES (CES-I) for patients with urinary difficulties of neurogenic origin, including altered urinary sensation, loss of desire to void, poor urinary stream, and the need to push to micturate; and 2) complete-CES (CES-C) for patients with painless urinary retention and overflow incontinence, where the bladder is no longer under executive control.[10]

In 2009, Fraser *et al.*[2] through a meta-analysis composed by 105 articles, defined CES as a state with at least one of the following symptoms: bladder and/or bowel dysfunction, reduced saddle area sensation, or sexual dysfunction with a potential neurologic deficit in the lower limbs.

Several studies defined CES with poor prognosis. Indeed, at long-term follow-up (FU) of CES patients, 36% presented micturition dysfunction sequelae, 40% defecation dysfunction, 50% sexual dysfunction, and 50% a motor deficit. The disabling nature of these sequelae causes significant medical and social morbidity as well as high socioeconomic costs.[6,11,12]

Furthermore, many studies have focused on prognosis factors especially concerning the time duration of symptoms before surgery but few of them focused on other prognostic factors such as complete or incomplete-CES, multilevel involvement, bilateral *versus* unilateral sciatic pain, or the presence of saddle anesthesia.[7,13–15] To date, the literature has clearly not identified any prognosis factors. Surgical management time is remarkably debated in the aim to obtain better outcomes and limit sequelae.

In our study, through a large series of operated CES patients, we aimed to identify prognosis factors for favorable functional recovery and to determine the real favorable impact of early surgery.

MATERIALS AND METHODS

Ethics Statement

The protocol can be found in the reference methodology MR003 chapter adopted by the CNIL to which the University Hospitals of Tours conform.

Study Population

A prospective database of 140 consecutive patients operated for CES between January 2010 and 2019 was generated from the Neurosurgery Department. All patients underwent diagnostic and preoperative imaging before the extraction of the herniated lumbar disc responsible for the CES.

Clinical Symptom Evaluation

Motor deficits were graded on a scale of 0 to 5 according to the Medical Research Council scale for muscle strength.[16] Sensitive deficits were also evaluated according to the Medical Research Council scale, with "0" representing disappearance, "1" altered, and "2" normal sensitivity.[16] Bowel dysfunctions were evaluated during the FU with the neurogenic bowel dysfunction (NBD) score[17] and bladder dysfunctions were defined by the Urinary symptoms Profile.[18] The genital dysfunctions were collected at clinical examination: saddle anesthesia and interrogation about sexual dysfunction (erectile dysfunction or vaginal dryness).

Statistical Analyses

All tests were two-sided; P values < 0.05 were considered statistically significant. Univariate and multivariate Cox proportional hazard regression models were conducted using SPSS software, version 22.0 (SPSS, Chicago, IL). Establishment and verification of nomograms were implemented using the open source software R-version 3.2.5 with rms packages (Design, Vienna, Austria). Data are presented as the mean/median $\pm$ standard deviation. The distribution of categorical variables was described with frequencies and percentages, whereas continuous and normally distributed variables were described with means and standard deviations (SD). In the univariate analysis, categorical variables were assessed using Pearson Chi-square or Fisher exact test. The multivariate analysis was conducted separately for each diagnosis and the Cox proportional hazards model was used to estimate hazard ratios and 95% confidence intervals (CIs). The output was expressed as odds ratios and their bootstrapped 95% CIs. The Kaplan–Meier method was used to estimate the metastases free survival? For descriptive and inferential analyses, boot-strapping with replacement (iterations = 1000) was performed to attain variance estimates at the 95% CI.

RESULTS

Patient Characteristics

One hundred forty patients were included in our study (Table 1). As summarized in Table 1, there were 73 females and 67 males (52.1/47.9%) with a median age of 46.8 years (range 18–86 yrs). The mean FU of patients was 15.5 months (SD 6.1). At presentation, lumbar magnetic resonance imaging diagnosed herniated discs for 114 (81.6%) patients and 26 (18.4%) were diagnosed with a computed tomography scan. The Pfirrmann classification for discopathies and the levels involved in herniated discs were distributed in Table 1.[19]

Clinical Presentation

So, 72 patients (51.5%) had CES-C and (48.5%, n = 68) had CES-I (Table 1). Fifty-six patients (40%) presented sudden symptoms. The median time between onset of symptoms and the diagnosis of CES was 4 days (SD 62.2). One hundred ten patients (79.6%) presented previous unilateral (81, 57.8%) or bilateral (29, 20.7%) radicular pain. The median time between the onset of radicular pain and diagnosis of CES was 28 days for root symptoms (SD: 124).

Eighty-four patients (60%) presented a bilateral (28, 20%) or unilateral 56 (40%) motor deficit, in which 52 (37.1%) were multiradicular. Sixty-two patients (42.8%) presented a sensitive deficit (grade 1–2): 25 (20%) were bilateral. Concerning sphincter symptoms, 99 (70.7%) patients presented urinary dysfunctions; mainly incontinence (39; 27.9%), low stream (45, 32.1%), or bladder retention (29, 20.7%). In regards to rectal dysfunction, 62 patients (44.3%) presented bowel dysfunction. Genital dysfunctions were distributed as follows in 90 patients: 64.2% presented saddle anesthesia and 21 (15.0%) had an associated sexual dysfunction.

Surgery

All patients underwent surgical disc herniation decompression. Fourteen patients (10%) developed surgical complications mostly caused by incidental durotomy (11, 7.8%), hematoma (1, 0.7%). One patient presented early recurrence (day-2). Mean length of stay (LOS) was 6.9 days (SD 4.8). A majority of patients benefited from postoperative physiotherapy (100, 71.4%). Eighty-seven patients (62.1%)

TABLE 1. Patient′ Clinical, Imaging, and Postoperative Characteristics

Characteristics (140 Patients)	Value N (%) or [SD]
Age (yrs)	46.8 [14.5]
Gender	
Male	67 (47.9)
Female	73 (52.1)
Follow-up (mo)	15.5
Medical history	
Spine medical history	44 (31.4)
Spine surgery history	24 (17.1)
Obesity	30 (21.4)
Cancer	4 (2.9)
Cardiovascular history	23 (16.4)
Depression	10 (7.1)
Diabetes	2 (1.4)
Neurological history	7 (5)
Imaging	
Pfirrmann classification	
I	11 (7.8)
II	14 (10)
III	14 (10)
IV	60 (52.6)
V	15 (10.7)
Herniated disc location	
L3-L4	21 (15)
L4-L5	52 (37.1)
L5-S1	67 (47.8)
Symptoms presentation	
Onset	
Sudden	56 (40)
Progressive	84 (60)
Evolution time (d)	
Root symptoms	28 [124]
Cauda equina symptoms	4 [62.2]
Clinical examination	
Radiculalgia	
None	30 (21.4)
Bilateral	29 (20.7)
Unilateral	81 (57.8)
Motor deficit	
None	56 (40)
Bilateral	28 (20)
Unilateral	56 (40)
Deficit score	
0–2	17 (15%)
3	12 (10%)
4–5	84 (74%)
Sensitive deficit	
None	78 (55.7)
Bilateral	25 (20)
Unilateral	37 (26.4)
Urinary dysfunction	
Incontinence	39 (27.9)
Low stream	45 (32.1)
Bladder retention	29 (20.7)
Bowel dysfunction	62 (44.3)
Saddle anesthesia	90 (64.2)
CES complete/incomplete	72 (51.5)/68 (48.5)
Postoperative period	
Surgery complication	14 (10%)
Hematoma	1 (0.7%)
Incidental durotomy	11 (7.8%)
Failure	2 (1.5%)
Stay duration (d)	6.9 [4.8]
Kinesitherapy	100 (71.4)
Exit location	
Home	87 (62.1%)
Rehabilitation	53 (37.8%)

were discharged from the hospital and 53 (37.8%) were admitted to a rehabilitation center.

Recovery

Three visits were organized: V1 (2 mo), V2 (6 mo), and V3 (1 yr) (Table 2). At the first FU visit (V1) patients showed a statistical improvement of CES deficits: 49 of 84 patients (58.3%) recovered from their motor deficits ($P < 0.0001$), and 30 of 62 (48.3%) from their sensitive deficits ($P = 0.003$). Regarding sphincter CES improvement, 50 of 99 (51.5%) patients impaired their urinary/rectal dysfunctions ($P = 0.538$). Only 31 patients went back to work and one patient alone presented recurrence.

At the last FU visit V3, (median of 15.5 mo), results showed new improvements of motor and sensitive deficits: 57 of 84 patients with CES motor symptoms (67.8%) recovered from their deficit ($P < 0.0001$) and 39 of 62 (62.9%) improved their sensitive deficit ($P < 0.0001$).

Concerning sphincter symptoms, 52 of 99 (52.5%) patients improved their urinary dysfunction; mainly urinary continence (39; 27.9%), low stream/dysuria (45, 32.1%), or bladder retention (29, 20.7%) $P = 0.123$.

In regards to the 62 patients (44.3%) who initially presented bowel dysfunction, at the last visit, 22 (35.5%) presented a very minor dysfunction (NBD 0–6), 11 (17.7%) from minor to moderate dysfunction (NBD 7–13), and 29 (46.7%) severe dysfunction (NBD > 14) ($P = 0.09$). For genital troubles, only 20 of 62 (32.2) had an amendment of saddle anesthesia. No data was collected for sexual dysfunction improvement.

Prognosis of Motor and Sensitive Recovery

We identified that age >60 years ($P = 0.018$), L3-L4 disc herniation ($P = 0.003$), preoperative radicular pain ($P = 0.037$), severity of motor deficit (0–2) ($P < 0.0001$), bilateral deficit presentation ($P < 0.0001$), LOS < 3 days ($P = 0.0017$), absence of postoperative physiotherapy ($P = 0.036$), and also rehabilitation reeducation ($P < 0.0001$) were successively associated with motor recovery prognosis (Table 3). Cox multivariate proportional hazard model identified that bilateral motor deficit [OR 3.9, IC95%

TABLE 2. Functional Recovery at the First and Last Follow-Up Visit

	Value N (%) or [SD]	*P* Value
Median time 1st FU (mo)	2.46 [1.1]	
Motor deficit	49/84 (58.3)	<0.0001
Sensitive deficit	30/62 (48.3)	0.003
Genital and sphincter deficit	50/99 (51.5)	0.538
Back to work	31/130 (23.8)	–
Recurrences	1 (0.7)	–
Median time last FU (mo)	15.5 [16.2]	
Motor deficit	57/84 (67.8)	<0.0001
Sensitive deficit	39/62 (62.9)	<0.0001
Genital and sphincter deficit	52/99 (52.5)	0.551
Back to work	46/130 (35.8)	–

TABLE 3. Univariate (*P* Value Was Calculated by the Log-Rank Test) and Multivariate (*P* Value Was Calculated by Cox Regression) Analysis for Prognostic of Motor Function Recovery

	Univariate Analysis (*P*)	Multivariate Analysis (*P*)	OR (CI 95%)
Age (yrs)			
< 40 yrs	0.645		
[40–60] yrs	0.119		
> 60 yrs	**0.018**	0.132	2.368 [1.102–6.639]
Gender	0.673		
Medical history			
Spine medical history	0.165		
Spine surgery history	0.356		
Obesity	1.00		
Herniated disc location			
L3-L4	**0.003**	0.435	4.234 [2.009–8.511]
L4-L5	1.00		
L5-S1	0.204		
Symptoms presentation			
Onset (sudden/progressive)	0.385		
CES evolution time			
< 24 h	0.481		
[1–3] d	0.284		
[3–7] d	0.493		
>7 d	0.439		
Clinical examination			
Radiculalgia	**0.037**	0.239	1.923 [0,578–2.894]
Motor deficit			
Bilateral	**< 0.0001**	**0.022**	**3,943 [1,223–12,711]**
Deficit level			
0–2	**<0.0001**	**0.001**	**7,23 [1,234 – 21.719]**
Sensitive deficit	0.282		
Genital and sphincters symptoms	1.00		
CES complete/incomplete	0.367		
Postoperative period			
Surgery complication			
Incidental durotomy	1.00		
LOS > 3 d	**<0.0001**	**0.039**	0.193 [0.040–0.923]
No physiotherapy	**0.036**	0.345	
Rehabilitation	**<0.0001**	0.145	

Statistically significant data are in bold.

TABLE 4. Univariate (*P* Value Was Calculated by the Log-Rank Test) and Multivariate (*P* Value Was Calculated by Cox Regression) Analysis for Prognostic of Genito-Urinary Function Recovery

	Univariate Analysis (*P*)	Multivariate Analysis (*P*)	OR (CI 95%)
Age (yrs)			
< 40 yrs	0.08		
[40–60] yrs	0.360		
> 60 yrs	0.831		
Gender	0.217		
Medical history			
Spine medical history	0.338		
Spine surgery history	0.813		
Obesity	0.822		
Herniated disc location			
L3-L4	1.00		
L4-L5	**0.044**	**0.025**	**2.338 [1.112–4.915]**
L5-S1	0.372		
Symptoms presentation			
Onset (sudden/progressive)	0.585		
CES evolution time			
< 24 h	0.559		
[1–3] d	0.472		
[3–7] d	1.00		
>7 d	0.525		
Clinical examination			
Motor deficit	0.716		
Sensitive deficit	0.715		
Radiculalgia	0.394		
Cauda equina syndrome			
Bowel dysfunction	**0.007**	**0.038**	2.177 [1.045–4.537]
Dysuria/low stream	0.912		
Urinary incontinence	0.550		
Bladder retention	0.095		
Saddle anesthesia	0.133		
CES complete/incomplete	0.639		
Postoperative period			
LOS > 3 d	0.348		
No Kinesitherapy	0.9420		
Rehabilitation	0.675		

Statistically significant data are in bold.

(1.223–12.711), $P = 0.017$] and an initial deficit severity of 0 to 2 [OR 7.23, IC95% (1.234 –21.719), $P = 0.001$] as prognosis factors of poor motor recovery. In contrast, only short LOS < 3 were associated with better motor recovery [OR 0.193, IC95% (0.04–0.923), $P = 0.039$), independently to reeducation or physiotherapy. In multivariate analysis, we only determined initial motor deficit to independently represent a prognosis factor of poor sensitive recovery [OR 3.123, IC95% (0.834–10.71), $P = 0.008$].

Prognosis of Sphincter Recovery

Time of surgery did not demonstrate to be a prognosis factor for recovery (Table 4). We identified that initial herniated disc at L4-L5 level [OR 2.338, IC 95% (1.112–4.915), $P = 0.044$] and initial bowel dysfunction [OR 2.177, IC 95% (1.045–4.537), $P = 0.007$] were significantly associated with poor recovery. Whatever the deficit (motor, sensitive, or sphincterial), neither early decompression (<24 h), nor CES-C *versus* CES-I presented better recovery.

Prognosis of Returning-to-Work

At the end of the median FU of 15.5 months, only 46 of 130 (35.8%) patients returned to work (Table 5). In univariate analysis, we identified that a L5-S1 herniated disc ($P = 0.018$), initial motor deficit ($P = 0.015$), motor sequelae ($P = 0.001$), sphincter dysfunction sequelae ($P = 0.02$), and long LOS ($P = 0.02$) were associated with the returning-to-work prognosis. Cox multivariate proportional hazard model identified that poor motor deficit

TABLE 5. **Univariate (*P* Value Was Calculated by the KLog-Rank Test) and Multivariate (*P* Value Was Calculated by Cox Regression) Analysis for Prognosis of Back-to-Work.**

	Univariate Analysis (*P*)	Multivariate Analysis (*P*)	OR (CI 95%)
Age			
< 40 yrs	0.243		
[40–60] yrs	0.118		
> 60 yrs	–		
Gender	1.00		
Medical history			
Spine medical history	0.172		
Spine surgery history	0.325		
Obesity	1.00		
Herniated disc location			
L3-L4	0.472		
L4-L5	0.138		
L5-S1	**0.018**	0.900	0.732 [0.356–0.977]
Symptoms presentation			
Onset (sudden/progressive)	1.00		
CES evolution time			
< 24 h	0.236		
[1–3] d	0.134		
[3–7] d	0.826		
Postoperative period			
LOS > 3 d	**0.023**	0.399	3.933 [1.110–9.877]
No kinesitherapy	0.203		
Rehabilitation	**0.024**	0.760	0.483 [0.525–1.193]
Final sequelae			
Motor	**0.001**	**0.025**	**5.933 [1.252–28.123]**
Sensitive	1.00		
Genital and sphincters	**0.02**	**0.042**	**2.484 [0.992–6.220]**

Statistically significant data are in bold.

recovery (motor sequelae) [OR 5.93, IC 95% (1.252–28.123), $P = 0.025$] as well as poor sphincter recovery [OR 2.484, IC 95% (0.992–6.220), $P = 0.042$] were prognosis factors of low outcomes in returning-to-work.

DISCUSSION

The definition of CES remains unclear: like Gleave and Macfarlane[10] who stressed the importance of categorizing CES into incomplete/complete with urinary resection, other authors studied CES definitions and entities. Ultimately, the weakness in CES's definition has been recently demonstrated in a systematic review of the literature.[2] Indeed, within 61 identified studies, 20 (32.8%) did not define CES, and the rest (41, 67.2%) did so with significant heterogeneity.

Furthermore, in their recent meta-analyses, Srikandarajah *et al.*[20] highlighted that there existed a significant heterogeneity in the outcomes for patients who had undergone surgery for CES. Moreover, in the literature, no data to this day has established a simple clinical definition of CES, nor prognostic factors for functional outcomes. Due to the heterogeneity of this data, it appears impossible to analyze and edit guidelines for CES management support.

Finally, whether within a department or according to a practitioner there is no consensual definition of CES-I/-C. Thus, all the data collected according to these two pathological subgroups remain unclear with a risk of misdiagnosis to one category or the other. Given these definition weaknesses in qualifying complete/incomplete it seems absurd to separate these two symptom entities and determine different prognosis factors accordingly.

The young age of patients and the high percentage of sequelae makes it a serious mutilating and disabling pathology.[2] Sequalae can be extremely disabling with a significant impact on quality of life; a previously healthy patient may become incontinent (fecal and/or urinary) and lose penile and vaginal sensation, have a major disturbance of sexual function, with a motor deficit and sometimes a sensitive deficit or sciatalgia.[6,11,12,21] Moreover, CES is a surgical emergency, and few authors have demonstrated the need of earlier surgery to limit sequelae.[10,14,22]

Surgical Decompression Timing

Several studies have attempted to define intervention timing following CES onset based on functional outcomes. Historically, following their meta-analyses, Ahn *et al.*[15] proposed the concept of "within 48 hours" as a guideline for improved outcomes in these patients. However, this dictum has been widely debated.

In resemblance to our findings, some reviews depicted no significant difference in outcomes between early (before 48 h) *versus* delayed (>48 h) decompression[7,11,23] whilst others argued that early intervention in CES, regardless of the subtype (complete or incomplete), had higher likelihood of improved inpatient outcomes.[13] The odds of getting better were higher, however, this was shown for incomplete CES. In a systematic review and meta-analysis, Chau *et al.*[7] revisited the impact of timing to intervention on outcomes. They acknowledged the significant "discordance" in the literature relating to an emergency intervention favoring improved outcomes, but concluded on the lack of distinct evidence supporting the 48-hour dictum. DeLong *et al.*[24] demonstrated a significant improvement of urinary symptoms in patients receiving an intervention within 24 hours in comparison with 72 hours.

To illustrate this 48-hours-dogma, Daniels *et al.* reviewed the Lexis Nexis Academic Database, which offers information on US Supreme Court decisions from 1983 to 2010. Fifteen lawsuits were identified, and an intervention following a 48-hour time point from symptom onset was associated with an adverse legal decision against the treating surgeon.[25]

To clarify this question, Delamarter *et al.*[26] explored the relationship between the timing of surgery and the extent of neurologic recovery thanks to a dog-CES experimental model. After induction of 75% of circumferential constriction of the cauda equine, they determined functional neurologic outcomes in recovery for their different subgroups (decompressed immediately or at 1-, 6-, and 24-h or 1-wk intervals). They identified that despite the initial fast improvement in the early-decompression groups, all dogs equally recovered and regained locomotion and bladder function at 6-week FU.[26] Glennie *et al.*[27] confirmed the recovery of motor function despite the decompression time on rat models, but suggested that an early decompression could improve bladder recovery. The major bias of this previous study was the scale of time-decompression: 1 or 4 hours after compression which is much shorter than the real time of symptom evolution.[27] By cons, it is well established that in patients with CES secondary to trauma, timing to intervention is associated with little or minimal benefit for inpatient outcomes.[13]

The benefit/role of surgery and the prognosis factors of recovery are essentially for patient information about sequelae and postoperative rehabilitation care.[10]

A likely cause of the discordance in findings of all these studies could be the discrepancy between clinical examination, patient's subjective feelings and the evaluation scales for intimate impairments such as urinary, bowel, and sexual symptoms, especially for women.[21,28] In many studies, urinary and bowel symptoms are only evaluated by score questionnaires but not objective examinations. Recent studies show that a bladder scan measuring post-void residual volume improves the diagnostic of CES with a sensitivity of 94% and predictive negative value at 98.7% if post-void residual volume is > 200 mL. These simple examinations could be very useful in enhancing diagnosis precision and for patient health care.[29,30]

Furthermore, we suggest that many patients ignored their first sign of CES, and therefore consulted too late, once CES was installed. Hence, many symptoms progressed quietly and were unnoticed by patients. Thus, in our study, the median evolution time of CES symptoms was 4 days, a finding confirmed by König *et al.* who identified a median CES evolution time of 10 days.[31–33]

Genito-Urinary and Bowel Recovery

In our series, at the end of FU, 47.5%, 67.8%, and 35.6% kept urinary, genital, and bowel dysfunctions respectively. Our data was comparable with that found by Korse *et al.* who reported at the final FU for 75 patients with CES: 36% with urinary dysfunctions, 52% sexual dysfunctions, and 41% bowel dysfunctions.[6,28,34] Unfortunately, in our series, data on erectile or vaginal disorders could not be collected. In another study, Hazelwood *et al.*[35] reported for their 46 patients a higher percentage of urinary sequelae: 76%, 39% genital dysfunction, and 43% bowel dysfunction at 43 months of FU. McCarthy *et al.*[11] thanks to an important FU of 5 years demonstrated 43% with urinary dysfunction, 30% sexual dysfunction, and 57% bowel dysfunction. Finally, our data are comparable with those reported in previous smaller series.

We found that anal incontinence represented a prognosis factor in keeping genital and sphincter sequelae. This factor was identified in other studies. Moreover, urinary catheterization is also reported as a prognosis factor, but we did not collect this data.[6,11,36] In our study, as evocated by Korse *et al.*[28] dysuria was a risk factor in keeping genital and sphincter deficits, but it was not significant in multivariate analysis.

Complete saddle anesthesia was reported by two studies as a risk factor of sphincter sequels, but we did not demonstrate a significant difference, maybe due to the absence of difference in our criteria according to partial and complete saddle anesthesia.[7]

Motor and Sensitive Recovery

There are very few studies about motor and sensitive recovery after CES, probably because it was not clearly defined in the syndrome and moreover, the studies focused on urinary and bowel symptoms. Despite experimental studies demonstrating complete motor recovery at FU,[26,27] a large portion of patients kept a motor deficit: 32% in our study against respectively 52%, 20%, and 48% for McCarthy *et al.*, Olivero *et al.*, and König *et al.* studies.[11,37] The differences in results can be explained by numbers of patients (140 for our series, 56 for McCarthy's, 31 for Olivero's, and 73 for Konig), severity/percentage of initial motor deficit, and length of FU (15 mo to 5 yrs). In comparison with series that studied an isolated motor deficit secondary to a herniated lumbar disc, motor sequelae varied from 36% to 75% of patients, which is higher than rates found for CES.[38] In our series, most of the motor deficits were light (Levels 3–4 for 74% of patients) and were described as a better prognosis for recovery.[38] Thereby, we identified that a bilateral motor deficit and an initial deep deficit (0–2) were risk factors in keeping motor sequelae. Furthermore, in CES we wondered if the first appearance of a genito-sphincterian dysfunction allowed an earlier diagnosis, thus limiting motor impairment. Concerning sensory deficit, it was rarely studied: in our series, 18% of patients kept their sensitive deficit against 46% in the McCarthy *et al.*[11] study. These physical examinations and evaluations remain very subjective as highlighted by Suri *et al.*[39]

Back-to-Work

In our study, 31% of patients could return to work after CES. In others studies, percentages were better (51%)[35] and (70%).[36] Cauda equina syndrome is a disabling condition, rates in returning to work are lower than those found for a simple herniated lumbar disk pathology where 80% of patients can go back to work at 3 months.[40] CES significantly impacts socioeconomic costs, with important additional funding. Implicitly, final motor and sphincter dysfunctions were identified as risk factors of not being able to return to work. We did not identify other studies, which dealt with the prognosis factor of going back to work: however, it seems to be very important in view of the socioeconomic cost of this pathology.

In the United Kingdom and United States, CES sequalae is one of the major causes of litigation due to the resulting disabilities, invalidity, handicap, and the necessity to cease work.[2,41] Likewise, Gardner *et al.* reviewed the database of the Medical Protection Society in the United Kingdom. A 5-year analysis revealed that the mean payment per CES litigation amounted to £117,331 (maximum recorded settlement being £584,000–£20,100,077).[42,43]

CONCLUSION

CES remains a very disabling and mutilating syndrome with a significantly dark motor, urinary, and bowel prognosis for patients that remain young. The functional prognosis is poor, and few patients can return to work. The prognostic factors identified were mainly the initial severity of motor deficits. We believe that the characteristic of complete/incomplete CES should no longer be used since it has no impact on the recovery and the definition of the syndrome is ambiguous. The timing to intervention following CES is debated: our series as well as the previous studies have not clearly shown a timeframe for good recovery. Decompression should be done as early forward as possible.

Furthermore, as you pointed out, the only way to prevent CES is to educate the patient: 1) By instructing to look out for clinical signs that require immediate consultation: motor deficit, genito-sphincter disorders, and severe pain; 2) By teaching patients to search for these signs through self-examination and during everyday practices (intimate hygiene, intimate relationship); and 3) By identifying patients: since the main etiology of CES is a herniated disc, as far as we are concerned in our department, all patients who present a nonsurgical herniation are followed, informed, and educated to hunt down the signs of CES.

➢ Key Points

- ❑ CES entities and prognosis remain debated.
- ❑ Our large series of 144 CES patients operated intended to clarify prognosis factors for favorable functional recovery.
- ❑ We concluded that CES remains a very disabling and mutilating syndrome.
- ❑ A significantly dark motor, urinary, and bowel prognosis recovery.
- ❑ Early or later surgical CES decompression did not improve functional recovery.

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