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Urodynamic findings and urologic management of central cord syndrome

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Abstract

Purpose: Central cord syndrome is the most common incomplete spinal cord injury, although urodynamic data on this subset of patients is lacking. We aim to determine the typical urodynamic features associated with this condition.

Methods: Consecutive patients undergoing urodynamic studies in a tertiary spinal cord unit between 2014 and 2018 were retrospectively reviewed to identify those with central cord syndrome. Charts were evaluated for demographics, spinal cord injury classification, symptoms, urodynamic parameters and treatment. Data were analysed using descriptive statistics.

Results: A total of 131 consecutive patients undergoing urodynamic studies were reviewed and 33 were identified with central cord syndrome. Mean age was 46 years and 91% were male. The predominant spinal cord injury classification was American Spinal Injury Association D (52%). Overall, 94% (31/33) reported volitional voiding and normal bladder sensation. Video-urodynamics demonstrated neurogenic detrusor overactivity in 70% (23/33) of patients, with 15% (5/33) demonstrating leakage with neurogenic detrusor overactivity and 21% (7/33) having reflex emptying. In total, 94% (31/33) of patients had normal compliance, 42% (14/33) of patients had detrusor sphincter or bladder neck dyssynergia and 60% (20/33) had an alteration to their management plan following urodynamic study.

Conclusion: There is discordance between subjective patient-reported symptoms and objective urodynamic findings. About two-fifths of patients may have a potentially unsafe urodynamic bladder profile and urodynamics studies resulted in a change in bladder management in the majority of patients. Urodynamic assessment of patients with central cord syndrome is essential to determine which patients require further intervention.

Level of evidence: Not applicable for this multicentre audit.

Keywords

Neurourology, spinal cord injury, urodynamics, unsafe bladder, functional urology

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Introduction

Central cord syndrome (CCS) was described by Schneider in 1954, who characterised it as a condition disproportionately affecting the motor function of the upper extremities, with bladder dysfunction, typified by urinary retention.¹

CCS is the most common incomplete spinal cord injury (SCI) (or SCI syndrome) and represents 9–20% of all SCI patients.^{2,3,4} CCS is most often attributable to hyperextension injury, resulting from falls, sporting injuries or motor

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Table 1. ASIA classifications of 33 central cord syndrome patients.

ASIA classifications	Number of patients	Percentage
ASIA A	0	0%
ASIA B	2	6%
ASIA C	13	39%
ASIA D	17	52%
Unknown	1	3%

ASIA: American Spinal Injury Association.

vehicle accidents.⁵ The pathologic mechanism of CCS is thought to be related to injury to the corticospinal tracts and the potential for recovery is variable.^{6,7}

Prior studies on CCS have reported long-term rates of 65–84% for ‘good bladder function’, ‘continent’ or ‘good bladder control’, yet urodynamic study (UDS) or cystometric data were not available.^{8,9,10,11}

Despite CCS being a relatively common condition, there is a paucity of literature specifically examining UDS findings in this patient population. Smith et al. reviewed 22 men with CCS undergoing UDS and a wide variety of bladder findings were noted. Of these patients, three had normal bladder function, two had bladder outlet obstruction (BOO) secondary to benign prostatic hyperplasia, 11 had external detrusor-sphincter dyssynergia and one had a hypocontractile bladder.⁸

The aim of our study is to review our patient population with CCS who have undergone UDS in their work up of voiding dysfunction. We hope to better elucidate the typical UDS findings, as well as make recommendations for the clinician on the optimal bladder investigations and treatments for these patients.

Methods

Consecutive patients undergoing UDS in the Victorian Spinal Cord Service (a tertiary spinal cord unit) between 2014 and 2018 were retrospectively reviewed to identify those with CCS. Institution protocol includes routine UDS evaluation for all patients with SCI. CCS diagnosis was assigned by the treating neurologist and spinal physician. Institutional ethics review board approval was obtained and the principles of the Helsinki declaration were followed.

Data were tabulated to include patient demographics, level of injury, American Spinal Injury Association (ASIA) classification, patient-reported urinary symptoms, upper urinary tract imaging and co-morbidities. UDS information collected included uroflowmetry data (maximum flow rate (Qmax), voided volume and post-void residual volume), cystometrogram (CMG) data (detrusor overactivity (DO), maximum detrusor pressure

Table 2. Cystometrogram parameters.

Parameter	Number of patients	Percentage
DO	23/33	70%
Leakage with DO	5/33	15%
Reflex voiding with DO	7/33	21%
Normal bladder compliance	31/33	94%

DO: detrusor overactivity.

and presence/absence of incontinence) and pressure flow studies data (detrusor contraction generated, sphincter contraction, fluoroscopic findings). Impaired bladder compliance was defined as <10 ml/cmH₂O, impaired detrusor contractility was defined by Bladder Contractility Index (BCI = PdetQmax + 5Qmax) <100 , whereas bladder outlet obstruction (BOO) was defined as BOO Index (BOOI = PdetQmax – 2 Qmax) >40 as well as fluoroscopic/UD findings of detrusor sphincter dyssynergia (DSD). The management that was instituted as a result of UD was also recorded. Descriptive statistics were employed to summarise these findings.

Results

Demographics

In total, 33 out of 131 consecutive patients were identified with CCS after undergoing UDS evaluation. The mean age of patients was 46 years and 91% were male. The majority of SCIs (52%) were classified as ASIA D (Table 1). Mechanism for the majority of injuries were secondary to hyper-extension (91%). Of SCIs, 73% were traumatic, most commonly in the setting of a motor vehicle accident, 21% were secondary to a fall from standing height and 6% were in the setting of seizures. The mean time from injury to the first UDS test was 14 months.

A total of 66% (22/33) of patients had a successful trial of void following resolution of spinal shock; 11 patients required intermittent self-catheterisation (ISC) initially.

Overall, 9% (3/33) described bothersome lower urinary tract symptoms (LUTS) with 12% (4/33) reporting incontinence (one stress, three urge incontinence) and 9% (3/33) had recurrent urinary tract infections (UTIs). The ability to void spontaneously and the sensation to void was reported by 94% (31/33). Hydronephrosis was not detected on any surveillance ultrasound of upper tracts of the 15 patients who had documented ultrasound scans.

Cystometrogram data

Mean first bladder sensation was 167 ml and mean volume at normal desire to void was 416 ml. There was evidence

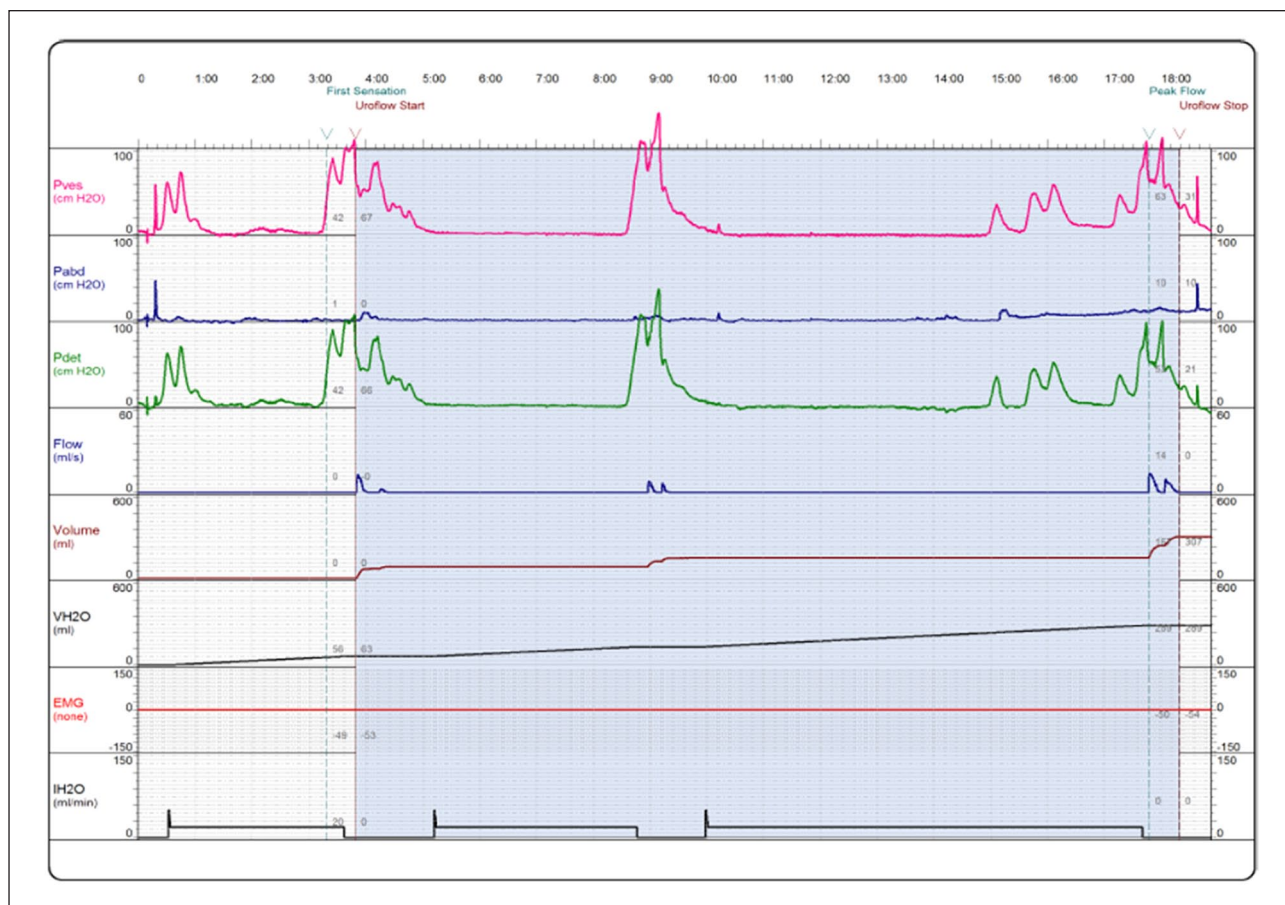


Figure 1. Urodynamics trace demonstrating neurogenic detrusor overactivity. Fluoroscopic imaging confirmed there was simultaneous contraction of the distal urethral sphincter with the bladder contractions, namely detrusor sphincter dyssynergia.

of neurogenic DO in 70% (23/33) of patients, with 15% (5/33) demonstrating involuntary neurogenic DO incontinence during the filling phase. In total, 21% (7/33) deliberately relied on DO contraction to reflex void, sometimes augmented with suprapubic tapping or Crede's manoeuvre. Normal compliance was found in 94% (31/33) of patients (Table 2). The remaining 6% (2/33) had mildly impaired compliance and no patients required a change to management as a result of compliance.

Pressure flow study data

Impaired bladder contractility was demonstrated by 18% (6/33) of patients and 58% (19/33) demonstrated some degree of BOO. Of patients with BOO, 74% (14/19) demonstrated DSD or bladder neck dyssynergia, with a mean voiding detrusor pressure of 82 cmH₂O (Figure 1). Eight of these patients had high voiding pressures of more than 120 cmH₂O. Fluoroscopically, four patients had bladder neck dyssynergia and 10 patients had external sphincter dyssynergia (Table 3, Figure 2). One patient demonstrated grade 1 vesico-ureteric reflux. The mean post-void residual volume was 101 ml.

Management

Following UDS, 60% (20/33) of patients had an alteration to their management plan (Table 4). An equal proportion were commenced on either oral therapy (anti-cholinergics or β -agonists) or intermittent self-catheterisation (ISC). Three patients were commenced on concurrent medications and ISC. One patient was non-compliant with ISC recommendation and a further two ended up with long-term suprapubic catheter secondary to poor dexterity. One patient went on to receive intravesical onabotulinum toxin A.

Follow-up UDS were performed on 15 patients. The median number of UDS performed per patient was two. One patient's UDS parameters improved to the point where they were voiding spontaneously and no longer needed ISC. For the remainder, there was no appreciable change to their UDS.

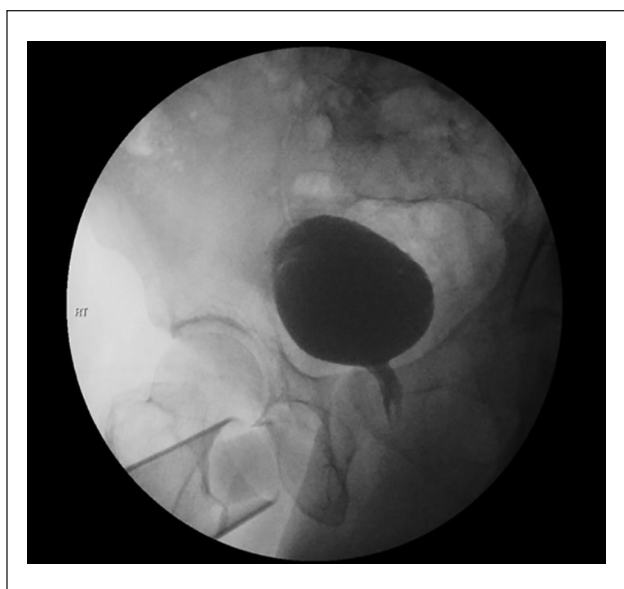
Discussion

CCS is a relatively common spinal cord injury and although the presentation of bladder function is mixed, little is known about expected UDS findings. Given it

Table 3. Pressure flow parameters.

Parameter	Number of patients	Percentage
Impaired bladder contractility	6/33	18%
BOO	5/33	15%
Detrusor external sphincter dyssynergia	10/33	30%
Bladder neck dyssynergia	4/33	12%

BOO: bladder outlet obstruction.

**Figure 2.** Fluoroscopic image of detrusor sphincter dyssynergia.

is a supra-sacral injury, one could expect neurogenic detrusor overactivity and some degree of sphincter dyssynergia. It is clear, however, from the above results that there is a wide variation of UDS findings ranging from impaired detrusor contractility and urinary retention to neurogenic detrusor overactivity incontinence. Interestingly, very few complained about bothersome LUTS. The concern is that this cohort of patients generally are functioning well physically and often assume they have normal voiding. Investigations therefore must be proactively arranged in this group of patients to institute appropriate management.

One of the most important findings for clinical practice is that 42% (14/33) of patients were deemed to have unsafe bladder characteristics. The bladder was 'unsafe' secondary to the elevated detrusor pressures on voiding, often in the setting of external DSD. We would therefore advocate that all patients with CCS undergo UDS to identify those with potentially unsafe UDS parameters.

Table 4. Outcomes following urodynamics.

Change in management	Number of patients	Percentage
Started on oral overactive bladder medications	11/33	33%
Started on ISC	11/33	33%
Intravesical onabotulinum toxin A	1/33	3%

ISC: intermittent self-catheterisation.

Neurogenic DO was common in this cohort, with 70% (23/33) having this finding during CMG with or without concomitant leakage. Up to 21% (7/33) of CCS patients relied on this detrusor contraction to reflexively empty their bladders. Conversely, 18% (6/33) patients had evidence of impaired bladder contractility, demonstrating the heterogeneity of this patient population.

Dvorak et al. described that over time, patients had significant improvement of their functional neurology, bowel and bladder, with up to 80% being continent.¹² They stated predictors of neurological improvement included patients with more formal education, fewer comorbidities, lack of spasticity and anterior column fractures. UDS, however, were not performed in that study. In our study, we did not demonstrate any significant change in UD patterns, at least within the first 3 years post injury and patients should be counselled appropriately to avoid complacency and a false sense of security. It remains unknown whether a longer period of follow-up may demonstrate change.

Limitations to this study include the relatively small number of patients, although this still represents the largest published series of UDS findings in CCS patients. It is also limited by the retrospective nature of the review and subject to the recorded information available to the reviewers. The management of individual patients is influenced by local practice patterns of the treating physicians and variability may exist in other institutions.

Conclusions

CCS presents with a spectrum of UD findings that are often discordant with the symptom profile reported by the patient. About two-fifths of patients may have a potentially unsafe UDS bladder profile and UDS resulted in a change in bladder management in the majority of patients. Failure to recognise and manage this may lead to recurrent UTIs, bladder decompensation and chronic renal impairment. Symptoms in this patient population are an unreliable guide and the clinician should seek objective evidence of bladder function with UDS evaluation to dictate management.

Conflicting interests

The authors declare that there is no conflict of interest.

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Ethical approval

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Informed consent

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