

Urodynamic assessment of detrusor function in the very acute phase of traumatic spinal cord injury: A prospective cohort study

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ABSTRACT

Introduction: The bladder is believed to be acontractile due to the phase of spinal shock and there is a lack of data on the detrusor function within the first few days after spinal cord injury (SCI). This study intended to assess the detrusor function with invasive urodynamics (UDS) during the first 15 days of SCI.

Methods: This prospective observational study was carried out from January 2020 to June 2021 and consecutive stable patients older than 18 years of age who had a history of traumatic SCI within the past 15 days were screened for inclusion. For each patient, the International Standards for Neurological Classification of SCI Worksheet was filled. All patients underwent bedside invasive UDS within 15 days of injury.

Results: There were a total of 41 patients with a mean age of 35 years. The thoracic cord was most commonly involved (46.3%) with Type A AIS/A grade being the most common (68.2%). The mean duration of injury at the time of UDS was 6 days. Abnormality in the filling phase could be identified in six patients. Three patients had neurogenic detrusor overactivity (NDO), with one having a high-pressure phasic NDO and one having a sustained NDO. Two patients had poor compliance and one had borderline poor compliance. None of the patients generated any detrusor pressure during voiding cystometry.

Conclusions: In patients with SCI, 14.5% of the patients had abnormal findings during the filling phase on the UDS performed within 15 days of the injury. These findings are in stark contrast to the traditional understanding that the detrusor is acontractile during the early phase of the SCI and merit further evaluation.

INTRODUCTION

Involvement of the lower urinary tract is an important cause of morbidity and mortality among patients with traumatic spinal cord injury (SCI).^[1] The resulting neurogenic lower urinary tract dysfunction (NLUTD), by the virtue of either altered storage function such as neurogenic detrusor overactivity (NDO) or poor compliance or by deranged voiding function such as detrusor-sphincter dyssynergia, can result in upper urinary tract deterioration and subsequent renal

failure.^[2] Invasive urodynamics (UDS) plays a pivotal role in both evaluation and planning of the management of NLUTD in patients with SCI.

It is commonly believed that during the initial or the acute phase of SCI, the detrusor is acontractile and that there is little to no threat to the upper urinary tracts during this phase of spinal shock.^[3] Rossier *et al.* found that in the patients with spinal shock, the detrusor is acontractile and

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the resistance at the level of internal as well as the external sphincter tends to increase with bladder filling resulting in the classical presentation of urinary retention.^[4] As a result, traditionally, UDS is performed in the chronic phase of SCI, with the recommendation being to perform it within the first 3 months after the trauma.^[5]

However, recent studies have challenged this common notion and have reported unfavorable UDS parameters in the early post-SCI period. In one such study, unfavorable UDS parameters were recorded in 63% of the patients evaluated within 40 days of SCI and the authors recommended early evaluation of patients with NLUTD.^[6] Besides, it is also suggested that early treatment of NLUTD can possibly prevent or at least delay the deterioration in the storage and the voiding function of the detrusor and can safeguard the upper urinary tracts.^[7] The optimal time for evaluation of the lower urinary tract in a patient with SCI is still debatable, and currently, there is no literature on the UDS findings of patients in the very acute phase of SCI, which is defined as within the first 15 days after the injury.^[8] Thus, we planned this prospective study to evaluate the lower urinary tract function of patients in the very acute phase of SCI, i.e., within the first 15 days of injury.

MATERIALS AND METHODS

This prospective study was carried out at a tertiary care institute from January 2020 to June 2021 after approval by the institute's ethical committee. Consecutive patients older than 18 years of age who had a history of traumatic SCI within the past 15 days were screened for inclusion. All patients had already received the intended neurosurgical or orthopedic intervention for the SCI and were stable and under observation. Unconscious patients, those requiring immediate intervention, those with concomitant multiorgan injury, those with concomitant brain injury, and those with congenital urological abnormalities, or prior urological surgeries, or history suggestive of urological diseases, were excluded from this study.

All patients underwent a clinical examination. The details of the spinal injury, neurological level, and the completeness of injury as per the American SCI Association Impairment Scale (AIS) were recorded on the International Standards for Neurological Classification of SCI Worksheet. A bedside ultrasonography was performed in all the patients and those with hydronephrosis or abnormalities of the upper tract were excluded from the study. All patients underwent bedside UDS within 15 days of injury, which was performed following the good UDS practices laid down by the International Continence Society.^[9] The UDS was performed on the Aquarius TT by Laborie, and the machine was transported to the patient's bedside. The bladder was filled with body-warm normal saline, and the rate of infusion was calculated by formula body weight divided by four

with the patient in the supine position. The patient's heart rate and blood pressure were monitored throughout the procedure with noninvasive monitoring and in the case of autonomic dysreflexia, defined as an increase in the systolic blood pressure of more than 20 mmHg above the baseline, the UDS was aborted and the bladder was emptied. The UDS findings were reported in accordance with the terminology for adult NLUTD defined by the International Continence Society.^[3,10] Any NDO, elevation of storage pressures, poor compliance (defined as ≤ 20 ml/cmH₂O), or detrusor sphincter dysynergia recorded on the UDS were deemed abnormal findings. Absent bladder sensation was defined as per the International Continence Society terminology discussion 2018 as "no bladder sensation during filling cystometry, at least to expected capacity of 500 mL" and the filling was stopped at 500 ml in these patients.

The data were entered into a spreadsheet and the statistical analysis was performed with Statistical Package for the Social Sciences (SPSS) for windows version 21 (Armonk, NY, USA: IBM Corp.).

RESULTS

A total of 41 patients were included and underwent UDS within 15 days of SCI. The mean age was 35 years (18–65 years) and the majority of the patients were male (82.9%, 34 out of 41). Fall from height (56.0%) was the most common mode of injury followed by road traffic accident (34.1%), fall of a heavy object over back (7.3%), and violence (2.4%), respectively. The thoracic spinal cord was most commonly involved (46.3%) followed by the lumbar (31.7%) and cervical cord (21.9%) and none had sacral SCI. Most of the patients were classified as AIS Type A (68.2%) followed by Type B (19.5%), Type D (7.3%), and Type C (4.8%). The demographic details of the patients included are presented in Table 1. All the patients were on an indwelling urethral catheter at the time of UDS and were not yet started on any bladder-specific management.

The mean duration between injury and UDS was 6 days (range – 1–14 days). The mean bladder capacity was

Table 1: Demographic profile of the patients included in the study

Characteristic	n (%)
Mean age (years)	35
Males	34 (82.92)
Females	7 (17.08)
Spinal injury level	
Cervical	9 (21.95)
Thoracic	19 (46.34)
Lumbar	13 (31.71)
AIS category	
A	28 (68.29)
B	8 (19.5)
C	2 (4.885)
D	3 (7.32)

AIS=Association Impairment Scale

500 ml, the mean detrusor end filling pressure was 10.4 cm of H₂O (0.5–71 cm of H₂O) and the mean compliance was 160.4 ml/cm of H₂O (7.04–1107 ml/cm of H₂O). On the UDS evaluation, during the filling phase, the majority (35 patients) of the patients had a silent detrusor along with the absence of sensations. In the rest of the six patients, abnormal findings such as detrusor overactivity or poor compliance could be recorded in the filling phase [Figures 1 and 2]. In three of these six patients, NDO was recorded, of which one had high-pressure phasic NDO, another had sustained NDO and the third had detrusor–sphincter dyssynergia. All three of them had normal compliance and adequate capacity. In the other three patients, the compliance was affected and two of these had poor compliance (<20 ml/cmH₂O) and one had borderline poor compliance (21 ml/cmH₂O). None of the 41 patients generated detrusor pressure during voiding cystometry or leaked during the study. The details of these patients and the abnormal filling phase findings recorded on the UDS are summarized in Table 2. We could not find any significant difference in the abnormal filling phase UDS findings based on either the level of SCI or the AIS category [Table 3].

None of the patients developed autonomic dysreflexia or other UDS-related complications. The catheter was replaced in all the patients postprocedure.

DISCUSSION

Relatively, little is known about the detrusor muscle in the very acute phase of SCI. It is commonly assumed that within 3 months of injury, the detrusor muscle is acontractile because of the phase of spinal shock and is considered safe for the upper tracts.^[5,11] However, a handful of reports published in the literature, suggest that the aforementioned may not be true in a significant proportion of patients. In this study, we evaluated the UDS parameters of 41 patients in the very acute phase of SCI belonging to various grades of injury according to the AIS classification and performed a UDS within 15 days of injury. During the filling phase, abnormal findings that could potentially risk the upper tracts were recorded in 6 (14.5%) of the 41 patients. The mean duration from SCI to UDS was similar in the six patients with abnormal findings (3.33 days) as compared with the rest of the 35 patients (6.45 days, *P* = 0.158).

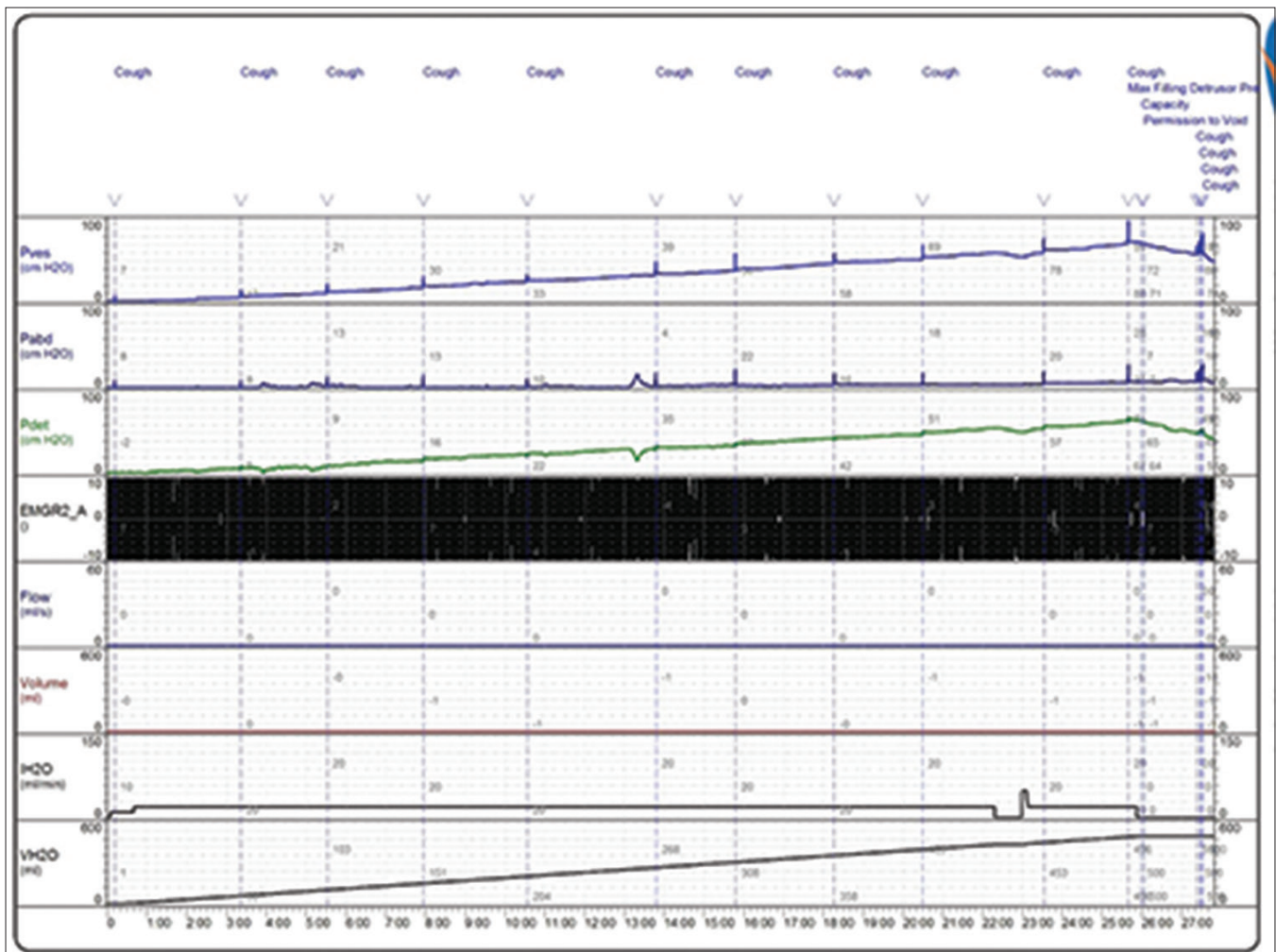


Figure 1: Urodynamic trace showing a poorly compliant bladder

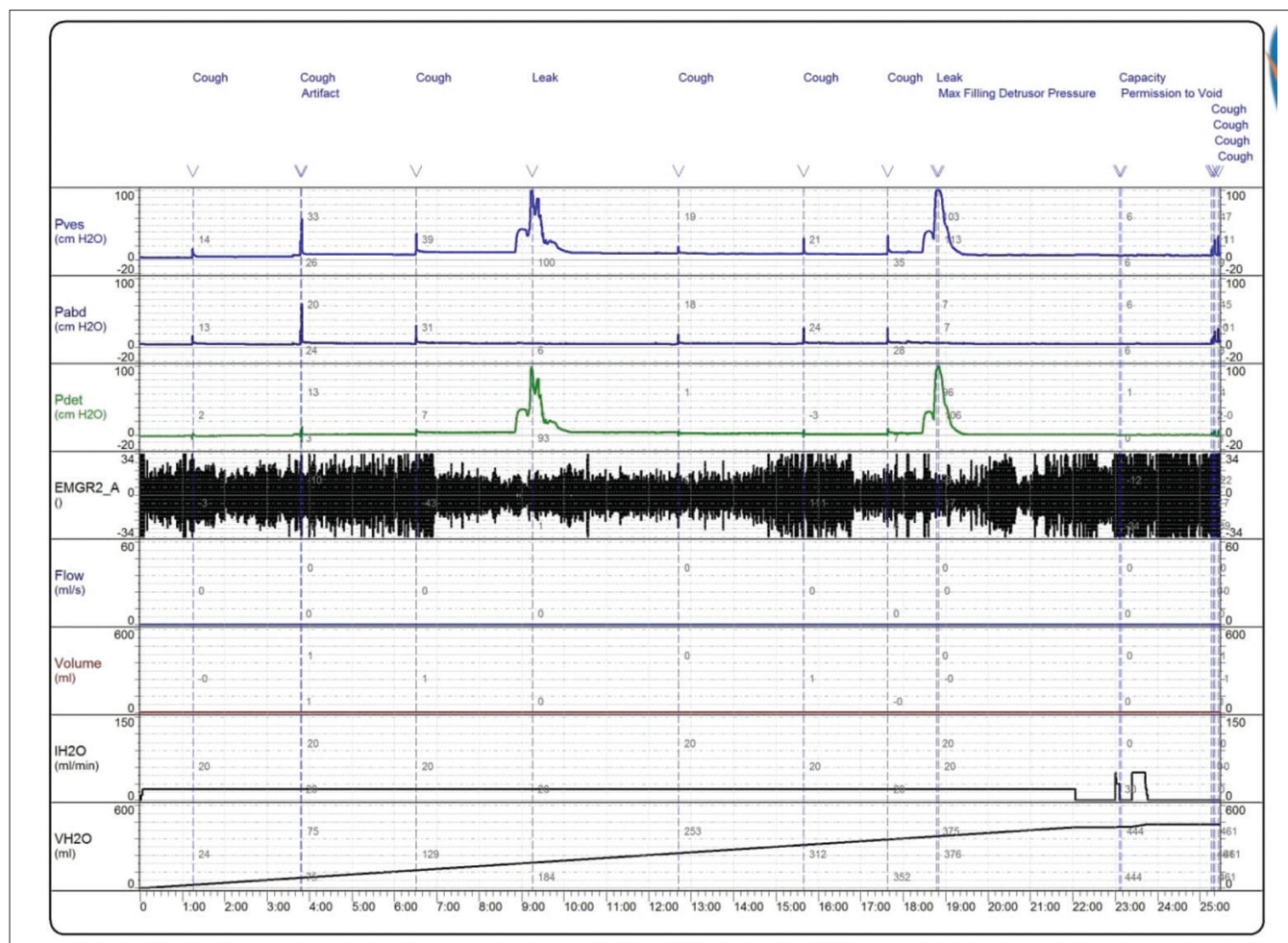


Figure 2: Urodynamic trace showing high-pressure neurogenic detrusor overactivity

Table 2: Details of 6 out of 41 patients with abnormal filling phase findings on the urodynamic study

Patient number	SCI level	ASIA impairment scale	Days from injury	Detrusor overactivity	Peak pressure of DO (cm of H ₂ O)	Sustained DO	End filling pressure (cm of H ₂ O)	Compliance (mL/cm of H ₂ O)
1	Thoracic	A	4	No			71	7.05
2	Thoracic	B	2	Yes	31	Yes	15	33.3
3	Cervical	B	4	No			23.7	21.09
4	Lumbar	A	2	No			30.8	16.2
5	Lumbar	D	4	Yes	105	No	0.4	1107
6	Lumbar	C	4	Yes*	27	No	12.2	36.8

*The patient also had detrusor external sphincter dyssynergia. ASIA=American Spinal Injury Association, DO=Detrusor over activity, SCI=Spinal cord injury

Table 3: Correlation of abnormal filling phase urodynamics findings with the level of spinal cord injury or the Association Impairment Scale grade

Category	Number of patients	Number of patients with detrusor overactivity	Number of patients with bladder compliance <20 mL/cm of water	Number of patients with maximum storage detrusor pressure >40 mL/cm of water	P
Overall	41	3	2	1	-
AIS grade					
A	28	0	2	1	0.67
B	8	1	1	0	0.53
C	2	1	0	0	0.41
D	3	1	0	0	0.50
Lesion level					
Cervical	9	0	1	0	0.80
Thoracic	19	1	1	1	0.92
Lumbar	13	2	1	0	0.76

*1 patient may have >1 finding. AIS=Association Impairment Scale

Few studies have reported UDS findings in patients with acute SCI. Bywater *et al.* performed UDS in 54 patients within 40 days of SCI and reported acontractile detrusor in only 37% of the patients. On the contrary, 63% of the patients had unfavorable UDS parameters.^[6] They found detrusor overactivity in 32 patients, detrusor–sphincter dyssynergia in 25, maximum storage detrusor pressure >40 cm of H₂O in 17, vesicoureteral reflux in 3, and low bladder compliance (<20 ml/cm H₂O) in 1 patient, with more than 1 abnormality being possible in 1 patient. The authors concluded that in contrast to the common notion of an acontractile detrusor during the acute SCI, almost two-thirds of the patients have unfavorable UDS parameters within the first 40 days of SCI. Similar findings were noted in the current study, with around 14.5% of the patients having abnormal filling phase UDS parameters, further adding to the evidence that the upper urinary tract may not be safe even in the first 15 days after the SCI. The lower incidence of abnormal filling phase UDS findings in our study as compared to that noted by Bywater *et al.* may be attributed to the shorter duration of time elapsed after the SCI.^[6]

Few studies have correlated the incidence or the severity of the UDS abnormalities with the status of neurological examination, the AIS impairment scale, and the level of SCI. Watanabe *et al.* evaluated 44 patients with AIS C to E SCI with a video-UDS study 3–14 days after the injury and found that 42% of those with AIS E injury, that is, neurologically completely intact had NLUTD on the UDS study.^[12] Furthermore, lower urinary tract dysfunction was present in 62% of the patients with intact pinprick sensation and in 59% with intact bulbocavernosus reflex. They concluded that an intact neurological system does not rule out abnormal bladder function. Similarly, Bellucci *et al.* compared the UDS parameters in 17 ambulatory and 43 nonambulatory patients at a mean duration of 30 days after SCI and found a similar incidence of unfavorable UDS parameters such as high-pressure storage phase, low compliance, detrusor overactivity, detrusor–sphincter dyssynergia, or vesicoureteral reflex.^[13] Bywater *et al.* also found that the unfavorable UDS parameters were present in patients with all levels of SCI as well as across all the grades of AIS.^[6] We were also unable to record a significant association between the AIS impairment scale or the level of injury and the incidence of abnormal filling phase UDS findings.

The initial days (0–1 days) after a complete SCI are usually characterized by a complete loss of deep tendon reflexes caudal to the level of injury.^[11] The recovery, however, is more varied and is further influenced by the completeness of SCI. Lu *et al.* compared the UDS findings in patients with complete and incomplete SCI and found that within the 1st month of injury, none of the patients with complete SCI had NDO as compared

to 9% of those with incomplete SCI.^[14] Furthermore, as the duration of injury progressed, the proportion of patients with NDO on the UDS also increased, probably due to the resolution of the shock phase and a return of the spinal cord function with time. We also noted that none of the patients in AIS A had NDO as compared to 23% of those with AIS B, C, or D. However, contrary to Lu *et al.*^[14], 7% of our patients with AIS A SCI had abnormal filling phase findings on the UDS related to poor compliance within the first 15 days of injury and thus deferring the UDS for 90 days in patients with complete SCI, as recommended by Lu *et al.*, may not be clinically safe.^[14] Bywater *et al.* and Bellucci *et al.* also found that a significant proportion of patients with complete SCI had unfavorable UDS parameters within the first month of injury and recommended a UDS evaluation as soon as feasible.^[6,13] Thus, the neurological examination, the level of SCI, and the AIS grade of injury have poor correlation with UDS findings and should not be surrogate markers for the management of the lower urinary tract.

This study has certain limitations. The number of patients involved is limited and heterogeneous, that is they belonged to a variety of levels of injury and AIS impairment scale categorization. Furthermore, a follow-up UDS was not recorded to assess a change in status in those with favorable as well as unfavorable UDS findings. Furthermore, the effect of any intervention in those with unfavorable UDS parameters within 15 days of SCI is also beyond the scope of this study.

With the available evidence, to assume that the bladder is “safe” in all patients during the acute phase post-SCI may not be entirely correct. The results of this study and those of others are thought-provoking and lend credence to the possibility that a subset of patients may actually be exposed to a “hostile bladder” from early on in the post-SCI period. However, almost invariably, the majority of the patients are on indwelling catheters at this time in their point of care and thus the impact of our findings on safety in these subsets of patients may not be that relevant. However, these findings become relevant once intermittent catheterization is initiated, and one may either opt for early UDS than the usually recommended or may opt to keep the patient on surveillance to look for features suggestive of abnormal storage pressures when an UDS can be planned. More studies on the subject and more data are required to ascertain the optimal timing of UDS post-SCI and until those are available the urologist should be aware that a safe bladder in the early phase post-SCI is not a universal phenomenon.

CONCLUSIONS

In patients with SCI, 14.5% of the patients had abnormal findings during the filling phase on the UDS performed within 15 days of the injury. These findings are in stark contrast to the

“traditional” understanding that the detrusor is acontractile during the early phase of the SCI and merits further evaluation.

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