

Clinical Protocol for Identifying and Managing Bladder Dysfunction during Acute Care after Traumatic Spinal Cord Injury

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Abstract

Bladder dysfunction is widespread following traumatic spinal cord injury (TSCI). Early diagnosis of bladder dysfunction is crucial in preventing complications, determining prognosis, and planning rehabilitation. We aim to suggest the first clinical protocol specifically designed to evaluate and manage bladder dysfunction in TSCI patients during acute care. A retrospective cohort study was conducted on 101 patients admitted for an acute TSCI between C1 and T12. Following spinal surgery, presence of voluntary anal contraction (VAC) was used as a criterion for removal of indwelling catheter and initiating trial of void (TOV). Absence of bladder dysfunction was determined from three consecutive post-void bladder scan residuals ≤ 200 mL without incontinence. All patients were reassessed 3 months post-injury using the Spinal Cord Independence Measure (SCIM). A total of 74.3% were diagnosed with bladder dysfunction during acute care, while 57.4% had a motor-complete TSCI. Three months later, 94.7% of them reported impaired bladder function. None of the patients discharged from acute care after a functional bladder was diagnosed reported impaired bladder function at the 3-month follow-up. A total of 95.7% patients without VAC had persisting impaired bladder function at follow-up. The proposed protocol is specifically adapted to the dynamic nature of neurogenic bladder function following TSCI. The assessment of VAC into the protocol provides major insight on the potential for reaching adequate bladder function during the subacute phase. Conducting TOV using bladder scan residuals in patients with VAC is a non-invasive and easy method to discriminate between a functional and an impaired bladder following acute TSCI.

Keywords: acute care; bladder; guideline; spinal cord; urinary function

Introduction

NEUROGENIC BLADDER following traumatic spinal cord injury (TSCI) caused by autonomous nervous system disorder attributable to spinal cord lesions affects up to 80% of all TSCI patients.^{1,2} Neurogenic bladder following SCI poses a plethora of risks to patients if not promptly diagnosed, including poor voiding, incontinence, urinary tract infections, vesicoureteral reflux, and kidney failure.¹ Further, SCI-induced neurogenic bladder is one of the main hindrances to both physical and mental health and quality of life in SCI patients.^{3–5} Some studies are even suggesting that functional limitations related to impaired bladder function are ranked higher than walking when patients are questioned about their rehabilitation priorities.^{3–7}

Given the significant length of stay (3–5 weeks) in Canadian SCI trauma centers,⁸ prompt and adequate management of bladder dysfunction prior to transfer to a rehabilitation unit is key in preventing important complications such as incontinence, upper urinary tract damage, and urinary tract infection during the acute

phase following SCI.^{1,2} Maintaining an indwelling catheter too long in patients without bladder dysfunction can potentially increase the rate of urinary tract infection, and also the risk of surgical site infection after spinal instrumentation.^{9,10} On the other hand, wrongly ceasing the use of the indwelling catheter in a patient with impaired bladder function also increases the risk of urinary tract infection, pressure injuries, and autonomic dysreflexia, while hindering social participation and quality of life.^{1,2}

In addition, sphincter rehabilitation, exclusively available in intensive inpatient rehabilitation units, plays an integral part in the management of bladder dysfunction in TSCI patients. However, because such specialized care incurs important costs, selecting the best candidates for intensive inpatient rehabilitation is critical in proper resource allocation. For this reason, identification of patients who present bladder dysfunction during acute care is essential in determining those most in need of sphincter rehabilitation.

Although the predicting factors of bladder function after TSCI have been previously studied, no prior evidence addresses the

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identification of bladder dysfunction during the acute period. For example, Pavese and coworkers² determined that the lower extremity motor score measured in the acute setting is the main predictor of adequate bladder function at 1 year following TSCI. However, this model does not provide any information on the state of bladder functioning at the time of assessment, nor does it help in selecting the best candidates for sphincter rehabilitation. Moreover, there is currently no clinical protocol available to acute care clinicians to identify and manage dysfunctional neurogenic bladder in this complex and distinctive population. As a result, individuals with acute TSCI are either currently left with the collecting system in place until admission to the inpatient rehabilitation phase, or are weaned off the collecting system in the acute post-operative phase without any specific protocol. Both scenarios often lead to preventable medical complications, inadequate bladder function diagnosis, and inefficient rehabilitation planning. Therefore, the use of a clinical protocol tailored to the acute SCI population would help clinicians to promptly identify and manage bladder dysfunction following TSCI, allow safe and timely removal of the collecting system in the post-operative phase, prevent medical complications, guide clinicians in determining the need for specialized sphincter rehabilitation, and promote efficient resource utilization while optimizing the patient's outcome.

In order to fill this gap, this study proposes a protocol designed to identify and manage the presence of bladder dysfunction in the acute phase following TSCI. This protocol is constructed around three key elements: (1) the assessment of voluntary anal contraction, (2) a trial of void accounting for the patient's ability to void spontaneously, and (3) the decision to wean or maintain the indwelling catheter until discharge from the acute center. Impaired bladder function in the subacute phase 3 months after the TSCI will be evaluated using the Spinal Cord Independence Measure III (SCIM). In doing this, we will verify if the protocol misclassified patients with impaired bladder function as having a functional bladder during acute care, as impaired bladder function is demonstrated by the use of any device for bladder management 3 months post-injury. In addition, we will document the rate of conversion from a dysfunctional bladder during acute care to a functional bladder 3 months after the TSCI.

Methods

This study was conducted on a retrospective cohort from a single level 1 trauma center specializing in SCI care. Patients consecutively admitted and surgically managed for an acute TSCI between March 2012 and November 2018 were included. Ethics approval from the institutional review board and written informed consent were duly obtained for this study. Inclusion criteria were: (1) being ≥ 18 years of age, (2) neurological level of injury (NLI) between C1 and T12 (3) TSCI with American Spinal Injury Association (ASIA) Impairment Scale (AIS) grade A–D, (4) surgical and perioperative care at Hôpital du Sacré-Coeur de Montréal, and (5) follow-up at 3 months. Exclusion criteria for this study were: (1) protocol for managing bladder function not followed or not documented properly by the acute care team, (2) presence of conus medullaris or cauda equina syndromes associated with the presence of areflexic (atonic) bladder dysfunction, (3) bladder dysfunction or indwelling catheter in place prior to TSCI, (4) death during acute care hospitalization, (5) previous neurological disorder (SCI, stroke, traumatic brain injury [TBI]) as these conditions may be associated with pre-existing neurogenic bladder dysfunction,¹¹ and (6) SCIM not available at follow-up.

Baseline characteristics

Sociodemographic, clinical, and trauma-related information were collected. Sociodemographic data included age and sex. The

initial severity of the TSCI was reported using the AIS grade and the NLI based on the International Standards for the Neurological Classification of Individuals with SCI (ISNCSCI).¹² The neurological examination is routinely performed during the pre- and post-operative periods following admission for a TSCI at Hôpital du Sacré-Coeur de Montréal. The post-operative neurological assessment, including rectal evaluation, is performed on average 5 days after the TSCI by a trained physical medicine and rehabilitation physician specialized in SCI care when the patient is able to undergo a complete neurological assessment. The rectal evaluation, as an integral part of the ISNCSCI, includes involuntary anal contraction, which was determined by the ability to volitionally contract the external anal sphincter around the examiner's finger and was either rated as present or absent. The acute care length of stay was defined as the number of days between admission and discharge from acute care.

Protocol for identifying and managing bladder dysfunction

As per current clinicals following TSCI, all patients at Hôpital du Sacré-Coeur de Montréal receive an indwelling catheter before spine surgery, and keep it at least until all following conditions are met:^{13,14}

1. Hemodynamic stability is reached.
2. Strict attention to fluid status is no longer required (patient has a normal urine output).
3. Intravenous fluid administration is ceased.
4. There is no suspicion of urinary tract infection, as defined by the Consortium for Spinal Cord Medicine.¹³
5. The patient has no medical condition preventing catheter weaning.

When all these conditions are met, our protocol can be used to identify and manage bladder dysfunction following two stages (Fig. 1).

Stage 1. Assessing voluntary anal contraction. After spinal decompression and stabilization, the presence of voluntary anal contraction should be assessed when the patient is able to undergo a complete neurological examination. Assessment of voluntary anal contraction is included in the protocol because the innervation and functional recovery of the anal sphincter and bladder are thought to be closely related.^{15,16}

- In the presence of voluntary anal contraction, the trial of void (TOV) protocol is initiated.
- In the absence of voluntary anal contraction, the patient is considered to have a dysfunctional bladder. The indwelling catheter is left in place and the patient is transferred to a specialized rehabilitation unit after acute care. However, if voluntary anal contraction is recovered during the course of the acute care, then the TOV protocol is initiated.

Stage 2. Performing and interpreting TOV protocol in the presence of voluntary anal contraction. The pharmaceutical profile is revised and, whenever possible, medication that may hinder bladder function such as anticholinergic medication should be stopped before performing the TOV protocol, whereas medication used to treat benign prostatic hyperplasia should be continued.^{17–19} The TOV protocol involves the use of a bladder scan to assess the quantity of urine remaining in the bladder, a non-invasive portable bladder ultrasound device that is safe and comfortable to patients.^{19,20} The TOV protocol consists of the following steps.

1. Removing indwelling catheter.
2. Encouraging patient to stay hydrated so that fluid balance can be recorded.

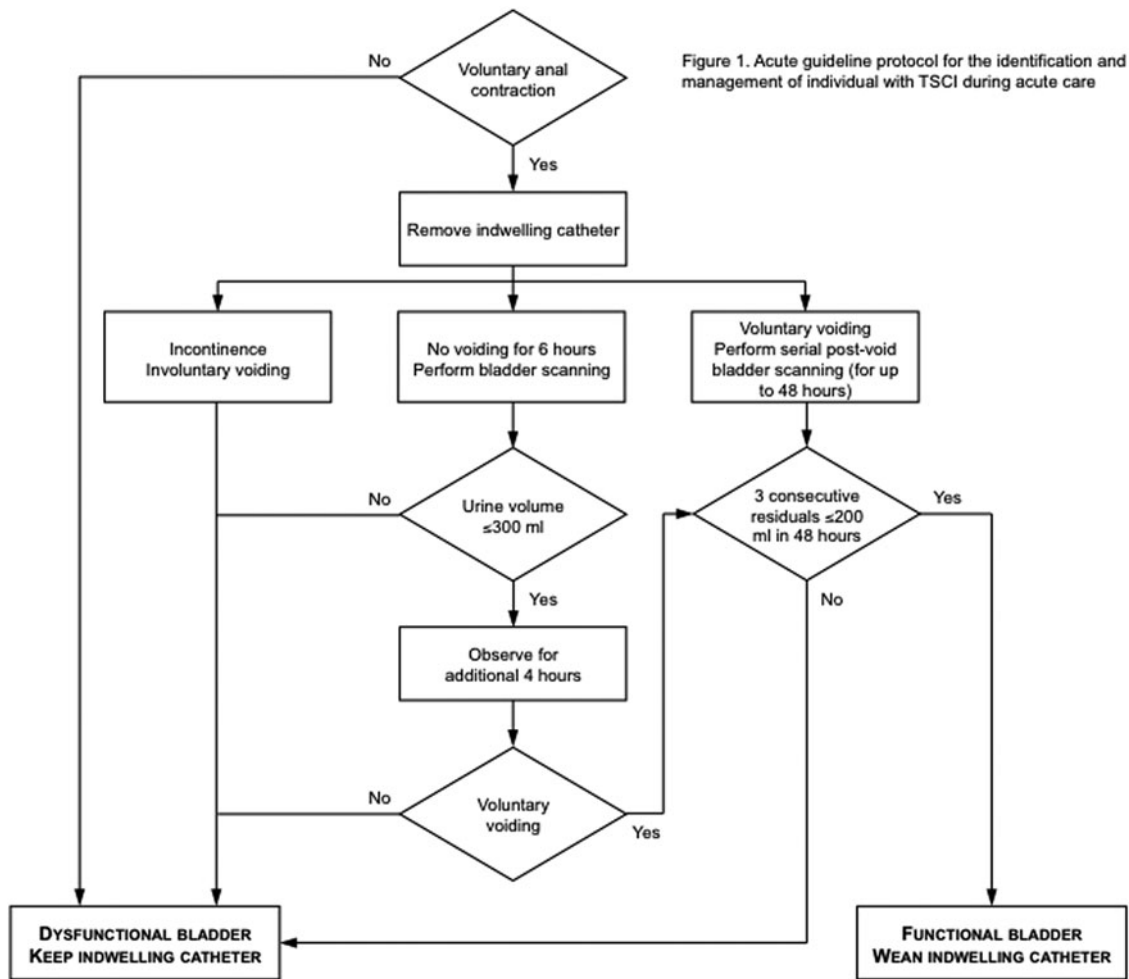


FIG. 1. Acute guideline protocol for the identification and management of individuals with traumatic spinal cord injury (TSCI) during acute care.

3. Advising patient to void as needed, and immediately notifying the nursing personnel after each spontaneous micturition. Three scenarios are then possible.
 - a. Urinary incontinence: in the presence of involuntary spontaneous voiding, TOV protocol is stopped, bladder is considered to be dysfunctional and indwelling catheter is inserted.
 - b. Voluntary spontaneous voiding: bladder scanning is performed to assess post-void residual after each micturition. TOV protocol is stopped when one of these two end-points are reached.
 - Three consecutive post-void residuals ≤ 200 mL are observed: bladder is considered to be functional, no indwelling catheter needed.
 - Forty-eight hours have elapsed without observing three consecutive post-void residuals ≤ 200 mL: bladder is considered to be dysfunctional, indwelling catheter is inserted. Proceed to urethral catheterization to empty bladder whenever post-void residual >200 mL.
 - c. No voiding for 6 h: perform bladder scanning to assess bladder urine volume.
 - i. If bladder urine volume >300 mL, TOV protocol is stopped: bladder is considered to be dysfunctional, insert indwelling catheter.
 - ii. If bladder urine volume ≤ 300 mL, patient is observed for an additional 4 h.
 - If there is spontaneous micturition, follow TOV protocol as such.
 - If there is no spontaneous micturition, TOV protocol is stopped: bladder is considered to be dysfunctional, insert indwelling catheter.
4. If patient is diagnosed with dysfunctional bladder, resumption of the TOV protocol (from step 1) is required whenever there is neurological improvement (for example improvement by 1 AIS grade) during acute care.

Outcome assessment

The presence of functional versus impaired bladder function at 3-month follow-up after the TSCI was determined using the third version of the SCIM.²¹ The SCIM is a reliable and sensitive tool specific to SCI, aimed at evaluating patients' ability to perform daily living activities independently.²² More specifically, the SCIM item 6 assesses bladder function from a score ranging from 0 to 15, with a score of 15 indicating the ability to void without requiring any catheter or device, and without any episodes of incontinence. Any score <15 indicates the need for a collecting device, catheterization, or the presence of some degree of incontinence. We have therefore chosen to dichotomize this outcome using a cutoff value of 15, as it distinguishes between patients with normal bladder function and those without. Functional level of bladder management was assessed during the subacute phase 3 months after the TSCI, because the great majority of patients will have completed

TABLE 1. BASELINE CHARACTERISTICS OF PATIENTS WITH TRAUMATIC SPINAL CORD INJURY AND COMPARISON FOR INDIVIDUALS WITH AND WITHOUT A VOLUNTARY ANAL CONTRACTION

	Final cohort n=101	Voluntary anal contraction n=30	No voluntary anal contraction n=77	p value
Male (%)	78 (77.2)	23 (76.7)	55 (77.5)	1.00
Age (years old)± SD	50.2±17.5	54.2±18.3	48.5±17.0	0.14
AIS Grade				
A (%)	46 (43.0)	0 (0.0)	46 (64.8)	<10 ⁻³ *
B (%)	12 (11.9)	0 (0.0)	12 (16.9)	
C (%)	14 (13.9)	4 (13.3)	10 (14.1)	
D (%)	29 (28.7)	26 (86.7)	3 (4.2)	
Tetraplegia (%)	57 (56.4)	21 (70.0)	36 (51.4)	0.12
Paraplegia (%)	43 (42.6)	9 (30.0)	34 (48.6)	
Acute care LOS	27.3±18.6	20.8±12.8	30.1±20.0	0.02*

*p is significant if ≤0.05.

AIS, American Spinal Injury Association (ASIA) Impairment Scale; LOS, length of stay (in days); SD, standard deviation.

intensive functional rehabilitation, or otherwise established a sphincter management plan for community integration/living.

Statistical analysis

Baseline characteristics were reported for the entire cohort, as well as separately for patients with and without voluntary anal contraction. Student's *t* tests and χ^2 tests were used to compare the baseline characteristics between patients with and those without voluntary anal contraction for continuous variables and categorical variables, respectively. The rate of bladder dysfunction identified using the protocol during acute care, and the early subacute rate of impaired bladder function at 3 months post-injury, were also reported.

The rate of misclassification, defined as the rate at which patients were classified as having a functional bladder during acute care using the protocol but then having an impaired bladder function at follow-up, was reported. In addition, the rate of conversion from a dysfunctional bladder during acute care to an adequate bladder function 3 months after the TSCI was reported.

Results

Among the 157 patients eligible for this study, a total of 12 (7.6%) were excluded because the 3-month SCIM questionnaire was not filled out, 42 (26.8%) were excluded because protocol was

not properly followed or TOV information was missing, and 2 were excluded for a history of stroke.¹⁰ Therefore, a total of 101 patients remained for analysis.

Comparisons between included and excluded patients showed significant differences in the severity of the TSCI (AIS grade) and neurological level of injury. There was a significantly higher proportion of individuals sustaining an AIS grade A TSCI (45.5% vs. 3.7%, $p < 10^{-3}$) and a smaller proportion of AIS-D TSCI (28.7% vs. 64.8%, $p < 10^{-3}$) in the final cohort of patients considered for analyses compared with individuals who were excluded. A significantly smaller proportion of individuals with tetraplegia was also found in our final cohort (57.0% vs. 83.0%, $p = 0.001$). Socio-demographic characteristics (age and sex) were otherwise similar between included and excluded patients ($p > 0.05$).

Table 1 shows baseline characteristics of individuals with and without voluntary anal contraction prior to deciding whether to conduct a TOV or not (Stage 2 of protocol). Individuals with voluntary anal contraction showed a significant higher proportion with AIS-D TSCI (86.7% vs. 4.2%, $p < 10^{-3}$). Moreover, individuals with a voluntary anal contraction showed a shorter acute care length of stay than their counterparts (20.8±12.8 vs. 30.1±20.0, $p = 0.02$).

Figure 2 shows the rate of functional versus impaired bladder function during the acute care and at 3-month follow-up. A total of

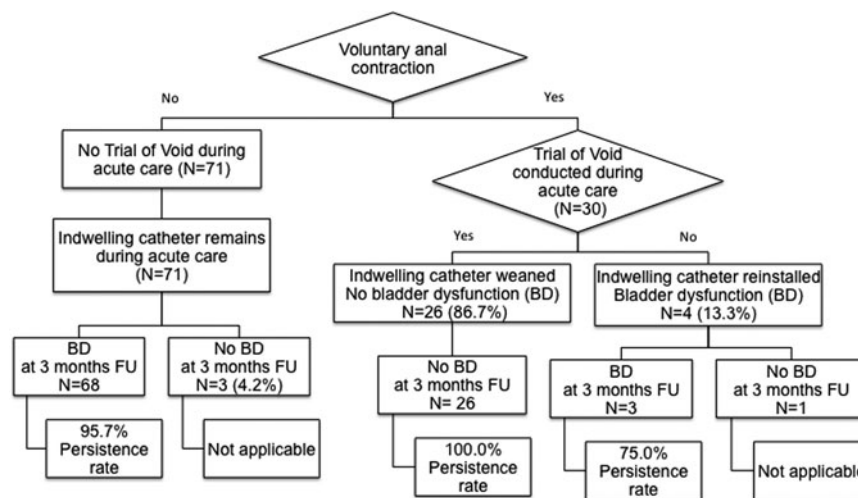


FIG. 2. Rate of functional and dysfunctional bladder during acute care as assessed by the guideline and at 3-month follow-up as assessed by the Spinal Cord Independence Measure questionnaire (n = 101)

75 patients (74.3%) were diagnosed with bladder dysfunction during acute care, whereas 71 of these 75 patients (94.7%) remained with impaired bladder function 3 months after the injury. The total prevalence of impaired bladder function 3 months post-TSCI was 70.3%.

A total of 71 patients (70.3%) did not have a voluntary anal contraction during acute care, and therefore the indwelling catheter was left in place throughout acute care. Among these patients, three (4.2%) reported normal bladder function at 3-month follow-up, whereas the remaining patients (95.8%) remained with impaired bladder function at this same time point.

A total of 30 patients had a voluntary anal contraction during acute care and underwent the TOV protocol. Using the TOV protocol, 26 patients (86.7%) were identified as having a functional bladder; they were able to wean from the indwelling catheter and void voluntarily until discharge from the acute care. On the other hand, four patients (13.3%) were identified as having a dysfunctional bladder, and the indwelling catheter was reinstalled. At the 3-month follow-up, one of the four patients (25%) initially identified as having a dysfunctional bladder reported a functional bladder with a score of 15 on item 6 of the SCIM.

The rate of misclassification from a functional bladder during acute care to an impaired bladder function at 3 months was 0%, indicating that all 26 patients for whom the indwelling catheter was removed after the TOV protocol during acute care (functional bladder) still reported no symptoms of impaired bladder function at the 3-month follow-up with a SCIM score of 15 on item 6.

Of the 75 patients diagnosed with bladder dysfunction during acute care, 71 (94.7%) still reported impaired bladder function at 3-month follow-up, indicating a rate of conversion of 5.3%. Three of the 71 patients without voluntary anal contraction (4.2%) and 1 of the 4 patients with voluntary anal contraction (25.0%) went from having a dysfunctional bladder during acute care to having adequate bladder function at 3 months.

Discussion

A majority of patients with TSCI are affected by neurogenic bladder, and this may lead to a myriad of complications if not promptly managed.^{1,2} This study characterized bladder function within the first weeks following a TSCI using non-invasive methods, as urodynamic testing is not recommended at this time because of the severity of neurological deficits during the post-operative period, the presence of associated multi-systemic dysfunctions (which put these patients at risk of hemodynamic instability), and these patients' high vulnerability to medical complications.^{13,23}

Given that the optimal management of neurogenic bladder during acute care remains unclear, this work also presents the first comprehensive protocol for identifying and managing bladder dysfunction following an acute TSCI. Using a systematic protocol for identifying and managing bladder dysfunction during acute care is highly important for different reasons. First, prompt identification and management of bladder function during acute care has a significant impact on preventing early and/or later complications, and on establishing a proper sphincter rehabilitation plan (if needed).²⁴ Second, proposed TOV protocols for other patient populations are not readily applicable because they do not account for the specific pathophysiology and dynamic nature of TSCI. Also, the pathophysiology of bladder dysfunction is distinct for TSCI patients, as it will evolve over time from the acute to the subsequent phases through the spinal shock process and neurological recovery, causing

the bladder to modify from an atonic to an overactive type.²³ In addition, prompt diagnosis of bladder dysfunction facilitates the counseling of patients and their families about prognosis and establishing rehabilitative goals.

The proposed protocol is also specifically adapted to TSCI patients because it is based on the presence versus the absence of voluntary anal contraction and spontaneous voiding. Identifying patients with absent voluntary anal contraction is important because it helps to decrease the unnecessary need to perform TOV in patients with bladder dysfunction, as performing a TOV protocol requires significant resources in the areas of time and expertise. Accordingly, 68 of 71 patients (95.8%) without voluntary anal contraction reported impaired bladder function 3 months after the TSCI. Three patients presented a functional bladder 3 months after the injury, despite being diagnosed with a dysfunctional bladder during acute care. These three patients most likely recovered bladder function in parallel with their neurological recovery from acute care, because their neurological status improved from T9 AIS grade D to S2 grade D, from T12 AIS grade B to L1 AIS grade D, and from C4 AIS grade C to C4 AIS grade D, respectively. Further, a subset of patients without voluntary anal contraction for whom a TOV had been done (unpublished data, as these six patients were excluded for the protocol not being properly followed), all failed the TOV protocol, supporting the presence of a dysfunctional bladder that has recovered between the discharge from acute care and the 3-month follow-up in these three patients. However, this finding also highlights that some patients might be apprehensive about contracting the external anal sphincter (or simply do not understand the order) during the acute phase, such that preservation of voluntary anal contraction could have been present but not detected during examination.^{15,25}

The presence versus the absence of spontaneous voiding is the mainstay of the second stage of the protocol, in order to determine how to conduct the TOV. Incontinence, as reflected by involuntary voiding following catheter removal, is an overt sign of bladder dysfunction. The absence of voiding in the presence of a full bladder is also an overt sign of bladder dysfunction.^{26,27} To that end, two aspects had to be considered for patients unable to void following catheter removal: (1) setting a cutoff value of 300 mL for bladder urine volume, as this will typically trigger micturition in individuals with normal bladder function,²⁸ and is widely accepted as a urine volume associated with urinary retention when a patient is unable to void,^{19,27,29} and (2) allowing sufficient time for accumulating 300 mL in the bladder (maximum 10 h) before stating that the patient is unable to void, while ensuring that the bladder is not distended on bladder scanning 6 h after catheter removal.

For patients able to void voluntarily, the protocol takes into account the dynamic nature of the functional recovery from a neurogenic bladder and the initial presence of spinal shock. Rather than relying on a single post-void residual, the TOV protocol allows up to 48 h with serial bladder scanning before diagnosing a dysfunctional bladder if the patient failed to show three consecutive post-void residuals ≤ 200 mL during that time frame. This cutoff value is in accordance with previous studies,^{19,30} suggesting that a post-void residual ≤ 200 mL will not be associated with acute urinary retention.

Surprisingly, the occurrence of bladder dysfunction during acute care and the persistence of bladder dysfunction are poorly documented in the literature. Overall, the results showed that 74.3% of patients presented bladder dysfunction during acute care, including one third of the patients with voluntary anal contraction. At 3-month follow-up, 70.3% of all patients presented with impaired

bladder function. Our study showed that bladder dysfunction can be observed for any AIS grade, although it is more likely with more severe AIS grades. It also shows that the rate of conversion from a dysfunctional to a function bladder between the acute care and subacute phases 3 months after the TSCI is relatively low at 14.6%. This is particularly true when there is no voluntary anal contraction during the acute phase (4.2%), as none of 46 AIS grade A patients, 1 of 12 AIS grade B patients, 1 of 10 AIS grade C patients, and 1 of 3 AIS grade D patients developed an adequate bladder function at 3 months post-TSCI. When considering only the patients without voluntary anal contraction sustaining a AIS grades C or D TSCI initially, only 15.4% (2 of 13 patients) had adequate bladder function. This is in contrast to the 90.0% rate of adequate bladder function in patients with voluntary anal contraction (all AIS grade C or D), showing that recovery of bladder function is strongly associated with presence of voluntary anal contraction during the acute phase. This finding underlines the importance of carefully assessing anal contraction during the acute phase in patients presenting with AIS grade C or D TSCI, not only to diagnose the actual occurrence of bladder dysfunction, but also as a predictor of recovery.

One of the most important benefits of using a systematic protocol for assessing bladder function is not to wean the indwelling catheter in a patient with a dysfunctional bladder, particularly when the patient is discharged home directly after acute care, without ongoing specialized SCI intensive rehabilitation care. To this end, using the proposed protocol was effective in achieving a rate of misclassification of 0%, indicating that all patients diagnosed with a functional bladder during acute care (for whom the indwelling catheter had been removed) remained with a functional bladder 3 months after the TSCI.

Although the proposed protocol assists in identifying and managing bladder dysfunction following an acute TSCI, clinical judgement is still important for identifying non-neurological causes of acute urinary retention that can superimpose on a neurogenic dysfunctional bladder. For example, intense pain following spinal surgery can require high doses of analgesics, a known cause of post-operative urinary retention.³⁰⁻³² It would be difficult, however, to integrate a withdrawal protocol of analgesics before proceeding to the TOV, given the key role of analgesics in patients' comfort and that the pain itself may contribute to urinary retention postoperatively.³³ Likewise, anticholinergics are known to cause urinary retention by reducing detrusor contractility.³⁴ Another potential cause of bladder dysfunction is the presence of urinary tract infection.³⁵ It is therefore suggested to frequently reassess for signs and symptoms suggestive of urinary tract infection and to ask for further investigations as needed.¹³ TOV should be conducted once treatment is completed and symptoms are resolved.³⁵ Older age is also associated with post-operative urinary retention,³¹ presumably because of pre-existing degeneration of neurological micturition pathways with advanced age, and/or a higher incidence of benign prostatic hyperplasia among older men.^{31,32} For this reason, optimal treatment of benign prostatic hyperplasia is suggested for patients prior to performing the TOV protocol.^{17,18} We also recommend that bowel management be optimized, as constipation at the time of catheter removal can also contribute to urinary retention.¹⁶

In centers where the acute length of stay is shorter than our actual length of acute stay, the proposed protocol should still be applied as early as possible, as leaving an indwelling catheter in patients who meet the requirements for catheter weaning unnecessarily – and vice-versa – exposes patients to significant complications such as urinary tract infections.³⁵ In acute centers with sufficient resources to train patients in self-administered intermittent catheterization promptly after surgery, the proposed protocol can be considered as a starting point for initiating training.

Limitations

The main limitation to this study consists in its retrospective nature and relatively low number of patients. Despite this limitation, this study proposed the first comprehensive protocol for identifying and managing bladder dysfunction in acute TSCI patients. However, the authors acknowledge that a prospective study including a larger number of patients is required to validate its clinical use. The authors also acknowledge that recovery of bladder function can occur during the later chronic stage after a TSCI, and that longer follow-up would be required in future studies. Meanwhile, the subacute phase is an important phase during which significant recovery of bladder function can occur, as supported by the fact that our study reports a global rate of bladder function/dysfunction that is similar to that in other studies reporting the rate of bladder function/dysfunction during the chronic phase.^{2,36,37} Another limitation is the absence of urodynamic investigation in this study. Although this test represents the gold standard to objectively assess the neurological function of the lower urinary tract,³⁸ it does not capture the bladder management functional level. For this reason, we chose to assess bladder function through a more adapted outcome, the Spinal Cord Independence Measure, as it encompasses both the method of bladder management after discharge and long-term bladder health. The inclusion of patients with an NLI down to T12 is another limitation of this study. Indeed, the findings cannot be directly applied to patients with conus medullaris or cauda equina syndromes who are often affected by a dysfunctional bladder. Because the pathophysiology and recovery for these patients significantly differ from those for the included patients, further study is required to determine whether the proposed protocol would also be useful for this specific population.

Conclusion

There is a clinical need for using a systematic protocol during acute care, to identify and manage patients with impaired bladder function after a TSCI. The proposed protocol is specifically adapted to the dynamic nature of TSCI and the resulting bladder symptoms. Integrating the assessment of voluntary anal contraction into the protocol facilitates the identification of bladder dysfunction and provides major insight into the potential for recovering normal bladder function during the subacute phase. Conducting TOV using bladder scanning and strict criteria for bladder urine volume in patients with voluntary anal contraction is a non-invasive and easy method to discriminate between a functional and a dysfunctional bladder. In particular, it constitutes an effective tool to help clinicians select the best candidates for intensive sphincter rehabilitation, and more importantly, it prevents the risk of discharging a patient from acute care without proper continuum care (indwelling catheter and specialized sphincter rehabilitation) when the patient has impaired bladder function.

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Author Disclosure Statement

No competing financial interests exist

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