Urodynamic Management of Neurogenic Bladder in Spinal Cord Injury

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Abstract

Background: A spinal cord injury is devastating and produces profound changes in the life style of the individual and his family. It is difficult to predict bladder and sphincter behaviour on the basis of clinical somatic neurological deficits.

Methods: A prospective study of 100 spinal cord injury patients was conducted to establish a bladder management protocol. The urodynamic variables were assessed frequently. Clean Intermittent Catheterization (CIC) along with antimuscarinic drugs was instituted and response monitored. Nonresponders were offered Intradetrusor Botulinum toxin.

Result: Spinal shock lasted for upto six months and only 8% could be converted to CIC during the acute phase. A total of 82% patients underwent three to four urodynamic studies which revealed an increase in cystometric capacity and a decrease in the maximum detrusor pressures. This lowered the incidence of incontinence episodes and prevented upper urinary tract damage. Botulinum toxin provided only temporary relief.

Conclusion: Aggressive management of neurogenic bladder (NB) dysfunction is a crucial component of the rehabilitation programme for spinal cord injury patients. Repeated urodynamic studies are an essential aid in managing the evolving nature of the bladder dysfunction. Meticulous bladder management protocol can prevent upper urinary tract complications.

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Key Words : Spinal cord injury; Neurogenic bladder; Urodynamics

Introduction

Due to recent improvements in medical care, the outlook for patients with spinal cord injury (SCI) has undergone a transformation. Complete cervical myelopathy was described in the 5,000-year-old Edwin Smith Surgical Papyrus as an “ailment not to be treated”. Even at the beginning of the twentieth century, the two year mortality rate was 80%. However, the current 12 year survival rate is 85%. Better urologic care has been a major factor in the improved survival [1]. The social impact of this injury is particularly disturbing because it tends to involve young individuals (mean age of 26 years) [2].

It is difficult to predict bladder and sphincter behaviour on the basis of clinical somatic neurological deficits. The purpose of the urodynamic evaluation of SCI patients is to identify those at risk of developing urological sequelae and to determine the requirement of early intervention. Urodynamic studies are an established method of evaluating all patients with voiding dysfunction [1]. Complications like obstructive uropathy, calculi, urethral strictures and urinary tract infections occur in a significant number of these individuals which can be significantly reduced with scientific management.

Frequent dosage readjustments and higher doses of anticholinergic medications are required as the urologic status can change over time.

Material and Methods

A prospective study of 100 men in age group of 21 -56 years with the history of spinal cord injury admitted at the Spinal Cord Injury Centre (SCIC) and Paraplegic Rehabilitation Centre (PRC), Kirkee from Jul 2005 to Jul 2008 was conducted with an aim of establishing a bladder management protocol.

A detailed history was recorded with special emphasis on any associated injuries and the duration of the spinal shock phase. The treatment history included the present method of bladder management and medications prescribed. Any recovery in the neurologic function was noted. The physical examination included assessment of the level and completeness of injury. Sensation of the lower extremities along with penile, scrotal and perianal dermatomes was evaluated. The rectal tone and bulbo cavernous reflex was also assessed.

A baseline urodynamic study was done after their recovery from the spinal shock phase. Urodynamics was performed under antibiotic cover. The study comprised uroflowmetry, filling and voiding cystometry, and pressure-flow electromyography (EMG) in all patients, using the Albyn Medical Urodynamic unit (Smart Medical Group, UK & Spain)

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according to the recommendations of International Continence Society (ICS) [3].

Cystometry was performed using a 6 F double-lumen urodynamic catheter transurethrally and a rectal balloon catheter. Room temperature saline was used to infuse the bladder at a slow rate (10 ml/min). Surface electrodes were used for the EMG. The urodynamic variables assessed included the maximum cystometric capacity (MCC), detrusor-sphincter dyssynergia (DSD), detrusor leakpoint pressure (DLPP), the detrusor pressure at MCC (Pdetmax), and postvoid residual urine volume (PVR).

Patients with high detrusor pressures were also subjected to an ultrasonography (USG) of the kidney, ureter and bladder (KUB). An estimation of the blood urea and creatinine levels was done. A micturating cystourethrogram (MCU)/intravenous urogram (IVU) were done depending on the USG findings to detect any complications requiring intervention.

The patients with high bladder pressures with high residual urine volumes were placed on a supervised regimen of self/attendant administered four to six hourly CIC. The use of condom catheters to avoid incontinence was actively discouraged and that of indwelling catheters was restricted.

Antimuscarinic drugs were started initially with tablet oxybutinin 2.5 mg thrice a day and increased after a week to 5 mg thrice a day. Patients with inadequate response were either re-dosed to 10 mg thrice a day or placed on tablet tolterodine 2 mg twice a day which was increased to 4 mg twice a day after titration. Combination therapy was used as indicated. These patients were periodically reviewed (every three to six months) with repeated urodynamic studies to measure the pressures and ensure drug compliance.

Nonresponders were offered intradetrusor botulinum toxin-A (BOTOX). BOTOX was administered under local anaesthesia. However general anaesthesia was used for patients with incomplete SCI and in tetraplegics to avoid autonomic dysreflexia. BOTOX (100 units), diluted in 30 ml of normal saline, was injected into the detrusor muscle at 30 sites (1 ml/site) covering a maximum bladder surface avoiding the trigone. Miller's rigid operating cystoscope (17 F) with a Cook 18 G endoscopic needle was used for injections. Anticholinergics were withdrawn after two weeks.

Autonomic dysreflexia manifested in suprasacral cord lesions. Prophylactic tablet terazocin 4 mg once a day was prescribed for two days and their urodynamic studies were carried out under blood pressure and pulse oximetry monitoring. The procedure was abandoned with quick bladder decompression if dysreflexia manifested. Sublingual capsule nifedipine 10 mg was administered and titrated against response. The underlying urinary tract infection (UTI) was also treated.

The patients with persisting spinal shock, active UTI, bladder calculus, indwelling urethral catheter and those lost to follow up after first study were excluded.

Results

We analysed the data of 100 men in the age group of 21-56 years, with a neurogenic bladder following SCI. Of these 66%

were in the age group of 20-39 years and 11% were over 50 years of age. The time since injury ranged from three months to 18 years and spinal shock from three weeks to six months. Initial care providers attempted CIC in the initial phase of spinal shock. During this phase 38% patients reverted to and 54% persisted with an indwelling catheter and only 8% could be converted to CIC.

The spinal cord injury was categorized based on American Spinal Injury Association (ASIA) Impairment Scale Categories (Table 1).

A baseline urodynamic study was performed in all patients after the resolution of the spinal shock phase. The urodynamic findings are depicted in Table 2. CIC and anticholinergics were started. Oxybutinin alone was used in 52 % and combined with tolterodine in 28 % patients. Solifenacin was added in six patients. A total of 329 urodynamic studies were performed in the study group and 82% patients underwent three to four studies.

The majority of patients leaked at small volume infusions during the initial urodynamic study, with high DLPP, because of small bladder capacities and hypertonic bladder activity. Though there were variations between subsequent studies in almost every patient due to the inherent variability of urodynamics [4], there was an increase in cystometric capacity (Table 3), and a decrease in the maximum detrusor pressures (Table 4). This was found to lower the incidence of incontinence episodes between CIC. Complications encountered are listed in Table 5. Upper urinary tract changes were managed with more frequent CIC/an indwelling catheter for up to four weeks and increased doses of anticholinergics to reduce detrusor pressures.

BOTOX was used in four patients. A temporary relief for three to five months was seen, however reinstitution of anticholinergics was required thereafter.

Table 1

Classification of Spinal Cord Lesion Based on American Spinal Injury Association (ASIA) Impairment Scale Categories [1]

(A) Complete injury no function below neurological level of injury (NCI)	76 (76%)
(B) Incomplete injury, some sensation below NCI	12 (12%)
(C) Incomplete injury; minimal motor function below NCI	10 (10%)
(D) Incomplete injury; grade 3 movement below NCI	02 (2%)
(E) Normal sensory and motor function	Nil

Table 2

Baseline Urodynamic Findings

Spinal Cord	Normal	Detrusor Hyperreflexia with DESD* (%)	Detrusor Hyperreflexia without DESD* (%)	Detrusor Areflexia (%)
Cervical (n=42)	0	60	35	05
Thoracic (n=31)	0	85	15	0
Lumbar (n=22)	0	25	35	40
Sacral (n=04)	0	25	25	50

* Detrusor external sphincter dyssynergia

Table 3**Maximum cystometric capacity (MCC)**

MCC (ml)	Initial	Final
< 50 ml	18	0
51 - 100 ml	53	4
101 - 200 ml	15	35
201 - 300 ml	08	43
> 301 ml	6	8
Total	100	100

Table 4**Maximum Detrusor Pressure (Pdet Max)**

Pdet Max (cm of water)	Initial	Final
<40	12	36
41 - 80	39	51
81 - 120	43	9
>120	06	4
Total	100	100

Table 5**Complications**

Complication	Number of cases (%)
Urinary tract infection	58 (58)
Upper tract changes (Backpressure)	15 (15)
Autonomic dysreflexia	12 (12)
Chronic renal failure	6 (6)
Stricture urethra	6 (6)
Vesical calculi	4 (4)
Refractory hypotension	1 (1)

All 56 patients with injuries above D6 vertebral level underwent urodynamic studies. Despite terazocin prophylaxis, dysreflexia manifested in 12 patients. In our study, UTI was associated with dysreflexia in 10 cases, which resolved with empirical antibiotic therapy. The dosage of nifedipine was titrated to prevent hypotension in this group of patients. The treatment was converted to injectable antibiotics if patient did not respond to oral medication over 48 hours.

Discussion

The management of neurogenic bladder (NB) dysfunction is a crucial component of a rehabilitation programme for SCI [5]. A study by Model Spinal Cord Injury Systems of Care reported some degree of impaired bladder function in 81% of cases, after one year of injury [6]. This can result in a greater risk of urinary tract deterioration, giving rise to significant morbidity and occasionally to mortality [7].

The principal goals of managing NB are to preserve renal function and to maintain patient Quality of Life (QoL) by decreasing urological complications [8]. With a proper bladder management method that optimizes both renal function and social functioning, the person

with SCI can enjoy a much healthier life. Various approaches to managing urinary disorders have been developed in recent years, ranging from surgery to the ingestion of active drugs and CIC or the insertion of endourethral prosthetic devices.

CIC has been described as the safest and most appropriate method of bladder management in a SCI patient. However we found that CIC does not find acceptance initially with the patients and their care givers. Patient education about CIC at an early stage of his recuperation was found to increase his acceptance of the procedure when bladder management gained priority after his recovery from spinal shock. Lloyd et al [9], suggest that short-term management choice during the recovery period produces no real difference in the long term.

CIC is the preferred long-term management option for most patients. The key variables determining patient acceptance of intermittent catheterization are functional capability and continence. Functional capability includes the patient's intrinsic capabilities or the presence of a dedicated care taker. Most patients discontinue CIC due to urinary incontinence. Sometimes this is related to sphincteric weakness, but usually it is related to uninhibited detrusor activity. With aggressive management to achieve complete continence, excellent long-term compliance with intermittent catheterization is obtained. In our study 15% patients required indwelling catheters for bladder management, while 6% continued on reflex voiding. The remaining patients were managed on CIC.

Urodynamic studies are an established method of evaluating patients with voiding dysfunction, but initial urodynamic testing is usually deferred until six months after injury [10]. Upper urinary tract deterioration occurs in 9-40% of patients with SCI [11]. Though a figure of 40 cm of H₂O has been the accepted standard, Wyndaele [12] suggested that maximum detrusor pressures of 70 cm H₂O or greater caused upper tract damage in SCI. Gerridzen et al [13] found that among patients with hyperreflexia, elevated voiding pressures were associated with upper tract changes.

We found very low cystometric capacity with high detrusor pressures to be the norm during the initial study. MCC increased from below 100 ml in 71% during the initial study to above 200 ml in 51% in the final study. Similarly Pdet Max reduced in 36% to below 40 cm of H₂O and in 87% to below 80 cm of H₂O. Despite active bladder management backpressure changes were seen in 15% of cases. Chou et al [4], have described the normal ranges for variability of urodynamic studies in SCI neurogenic bladders, which help in determining the significance of inter study differences.

Failure of one antimuscarinic drug formulation necessitates that an attempt be made to increase dosage or to change the drug or offer a combination. This approach was found efficacious in our study and a combination of oxybutinin and tolterodine was used in 28% of our patients with benefit. Bennett et al [14], suggest aggressive dosing of oxybutinin up to 30 mg per day, with decreased incontinence episodes and no serious adverse events. Combining bladder training with drugs increases the effectiveness of tolterodine (2 mg twice daily) [15]. Tolterodine is effective even after Oxybutinin failure [16].

Intradetrusor injection with BOTOX has a role in treating drug-resistant Neurogenic Detrusor Overactivity (NDO). Because of its short duration of action BOTOX can postpone but not replace other treatment methods e.g. augmentation cystoplasty, in this selected group of patients. Until the long term effects and optimum number of effective BOTOX injections is known, interval BTX injections will tentatively bridge the gap between oral treatment and invasive surgical treatment [17,18]. The role of detrusor myomectomy in the management of neurogenic detrusor over activity is unproven [19].

Autonomic dysreflexia is a life-threatening emergency in which uncontrolled sympathetic activity occurs in patients with spinal cord injury (SCI) above the splanchnic outflow, usually at the level of the sixth thoracic vertebrae [1,20]. The first order of treatment is to remove the initiating stimulus. Vaidyanathan et al [21], have used long term terazosin as an effective prophylactic therapy for patients with recurrent symptoms of autonomic dysreflexia. Despite terazosin prophylaxis, dysreflexia manifested, in 12 patients out of the 56 with suprasacral cord lesions, in our study. Sublingual nifedipine can abort the acute episode of autonomic dysreflexia [22].

Patients with SCI, their families, care takers must be educated about this syndrome and its prevention. If there is a catheter it should be changed regularly. It has been recommended that urodynamic investigations be accompanied by accurate blood pressure monitoring [23], because of the risk of triggering the condition during the filling phase. Prompt and appropriate treatment of UTI is crucial and good bowel and skin care is important in preventing autonomic dysreflexia. Shergill et al [22], recommend that all patients with SCI should carry a card identifying them as having this problem.

UTI is the most common cause of fever in the spinal cord-injured patient [24]. Recurrent symptomatic infections should be treated as an indication for urinary tract imaging. These may be related to high storage pressures and should prompt urodynamic evaluation and review of their bladder management program [25].

In conclusion, repeated urodynamic studies are an essential aid in managing the evolving nature of bladder dysfunction in SCI. We recommend that three monthly studies be continued for the first year after reversal of the spinal shock, then six monthly for another year and yearly thereafter.

CIC is the safest and most appropriate method of long term bladder management in a spinal cord injury patient and we recommend that it should be introduced as early as possible. Antimuscarinic agents are effective at higher doses in post traumatic neurogenic bladders. Combination therapy is workable and dose titration against response is a continuous process.

Intradetrusor injection with Botulinum toxin is effective in neurogenic bladders resistant to anticholinergics. However because of its short duration of action it requires repeated invasive procedures. A dedicated bladder management protocol can prevent upper urinary tract complications resulting in decreased morbidity and mortality.

Conflicts of Interest

None identified

Intellectual Contribution of Authors

Study Concept : Lt Col R Khanna, Lt Col D Doddamani

Drafting & Manuscript Revision : Lt Col R Khanna

Statistical Analysis : Lt Col R Khanna

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Quiz

Radiological Quiz

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A 26 yrs old primigravida lady presented for routine antenatal ultrasonography at approximately 30 weeks of gestation. The axial section of brain of foetus at level of cerebellum is shown here (Fig.1). What is the diagnosis?

Fig. 1: Ultrasound image (axial section) of brain of foetus at 30 weeks gestation.

Answer to Radiological Quiz : pg. 363

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