Original Article

Urodynamic study of Bladder Behaviour in Traumatic Spinal Cord Injury Patients in Response to Rehabilitation

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Abstract

Objective: To study the bladder behaviour in response to rehabilitation intervention in traumatic spinal cord injury (SCI) patients using urodynamic study (UDS) and to compare the nature of the bladder in a rehabilitated and non-rehabilitated neurogenic bladder of traumatic SCI.

Study design: Prospective follow-up study.

Setting: Rehabilitation ward of National Institute for the Orthopaedically Handicapped.

Material and Method: Thirty traumatic SCI patients mean age 31.4±7.9 years, 26 males and 4 females, admitted for rehabilitation were done UDS to see the bladder behaviour in response to rehabilitation intervention and compare the nature of bladder of the rehabilitated and that of the non-rehabilitated neurogenic bladder. Rehabilitation of the bladder was done at least for three months. The study lasted for 2 years with a minimum of one year follow-up.

Result: In upper motor neuron (UMN) neurogenic bladders there were significant changes in the max. cystometric capacity (p=0.018) after rehab intervention. The compliance, Pdet. at first desire to void and Pdet. at max. cystometric capacity of these patients were also found to have significant correlations (p=0.012, 0.010 and 0.014 respectively). But the volume at the first desire to void does not show must significant changes after rehab intervention (p=0.45). Significant reduction of amplitude and frequency was found in involuntary contractions (detrusor hyper-reflexia). In similar comparison of the lower motor neuron (LMN) neurogenic bladder significant changes after rehab intervention, could be found only in the max. cystometric capacity (p=0.018). Other variables like compliance, volume at first desire to void, Pdet. at first desire to void, and Pdet. at max. cystometric capacity were found to have no significant changes after rehab intervention (p=0.168, 0.194, 0.324, 0.302 respectively).

Conclusion: The change in the nature of the rehabilitated neurogenic bladder is different with the type of bladder.

Key words: **Traumatic spinal cord injury, urodynamic study, neurogenic bladder.**

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Introduction:

Spinal cord injury has been known since thousands of years back i.e. since the Hippocrates' time. But its management has improved only few decades back, by focusing primarily on better bladder management. It is difficult to obtain Indian statistics of SCI due to difference in data collection. In one of the studies it is approximated to 20,000 new cases added every year.[1] According to the National Spinal Cord Injury Statistical Centre (NSCISC), approximately 12,000 new cases are added each year in U.S[2]. In developing countries, the road traffic accident and fall from height seem to be the most common cause of spinal fractures and spinal cord injuries.[1] The nature of injury varies with age, where motor vehicle crash is the leading cause of SCI until age 45; however, falls represent the leading cause of SCI in

age group 46 and above. Recreational sports and acts of violence decrease with advancing age as cause of injury. Men suffer traumatic SCI much more commonly than women, at a 4.2:1 ratio[2].

Renal failure arises as a result of bladder and sphincter dysfunction, infection due to stasis and amyloidal disease, are most common cause of mortality in chronic SCI till 1970s[3]. Over the past 40 years long term survival of the spinal cord injured patient has improved due to development of expertise units which has prevented lethal complications of pressure sores, respiratory and urological problems[4]. Unfortunately, despite these advances, permanent disability and problems with bladder still exist. Since urinary tract complications are related to altered bladder and sphincter function it means complications are preventable many a times. The urodynamic investigation has important role to know detrusor and sphincter status of the patient and plan its management accordingly[5,6]. In the present study UDS is used to assess the manifestations of the bladder following SCI. UDS is done in two groups of SCI patients, one who have not done any form of bladder rehabilitation and the other who have undergone a standard bladder rehabilitation programme.

Materials and Methods:

The study was conducted on thirty inpatients, admitted for institution based rehabilitation (IBR) in the rehabilitation ward of the National Institute for the Orthopaedically Handicapped, Kolkata as part of post-graduate training with due approval of the institute's ethical committee. The study was conducted for a period of 2 years (August 2007 to July 2009), and a minimum follow-up period of one year. The study included only the traumatic causes of SCI. A detailed clinical history, examination and a baseline investigation were taken for all patients. Written consents were taken after proper instruction given about the procedure of UDS. The cases were divided into two groups, (i) those who had never received any specific rehabilitation programme for bladder or were simply left with an indwelling catheter and (ii) those who had undergone rehabilitation programme of the bladder for at least 3 months, according to its type of manifestation in UDS with the available treatment protocols[3,7]. Patients who came to us without any bladder rehabilitation for 3 months or more since the time of injury were included in the first group. Patients who came earlier were included in the latter group. UDS was performed and treated according to the findings. Treatment includes catheterisation, intermittent clamping, intermittent catheterisation, behavioural therapy and oral medications (oxybutynin or tolterodin) depending on the nature of the bladder. Interventions like botulinum toxin injection of detrusor were not included.

As part of patient preparation they were given two tablets of dulcolax (bisacodyl 5mg) or in suppository form (10mg) on the night before the test. Next morning on the day of examination they were asked to void their bowels and not to take any solid food till the test is over. UDS was done and recorded for both filling and voiding cystometry using multichannel auto pumping urodynamic machine (Medtronic DUET® LOGIC G|2, Software: IEC Publication 60601-1-1). Normal saline at room temperature was used for infusion at the rate of 50 ml per minute. All the patients were instructed to take ciplox 500 mg (ciprofloxacin) just after the test and continued for 3 days two times daily.

For comparison basis we have divided the cases into four main groups viz, rehabilitated upper motor neuron, rehabilitated lower motor neuron, non-rehabilitated upper motor neuron and non-rehabilitated lower motor neuron cases. To compare the changes of the quantitative variables after rehabilitation in comparison to the non-rehabilitated, unpaired Student's t-test was used. The result was considered significant at 5% ($p<0.05$) level of significance. The analysis was carried out using statistical package "SPSS V7.5".

Results:

Out of the 30 patients, 86.7% (n=26) were males and 13.3% (n=4) were females. The mean age group was 31.4±7.9 (range 17- 45 years). Maximum number of patients belong to the age group 26–40 years (60%, n=18) (Table 1).

Road traffic accident (RTA) was the most common cause (50%, n=15) followed by fall from height (23.3%, n=7). Majority of the patients were daily labour (23.3%, n=7). The mean duration of stay in the rehabilitation ward was 75.16±29.4 days (range between 16 and 145 days).

Nineteen patients (63.33%) have UMN type of neurogenic bladder of which 17 (56.65%) have detrusor hyper-reflexia with detrusor sphincter dyssynergia (DSD) and 2 (6.66%) without DSD. Of the 19 patients, 18 were of suprasacral spinal cord lesion, including cervical (4), thoracic (12), lumbar (2) and 1 sacral segment. Eleven patients (36.66%) have LMN type of neurogenic bladder

of which 4 (13.33%) were of lumber segment lesion and 7 (23.33%) of sacral segment lesion (Table 2).

Of the 19 UMN type bladders, 9 (30%) were of rehabilitated and 10 (33.33%) were non-rehabilitated bladder. Among the 11 LMN types, 6 (20%) were of rehabilitated and 5 (16.66%) were non-rehabilitated (Table 3). Comparison of the different variables of cystometry among the rehabilitated and non-rehabilitated was done using unpaired t-test. The values are summarised in Table 4. Another important variable that cannot be represented numerically but can be seen graphically is the involuntary contractions of the bladder (detrusor hyper-reflexia).

Discussion:

Neurogenic bladder (NB) following traumatic SCI is unavoidable and the management of NB dysfunction is a crucial component of a rehabilitation programme. It is difficult to predict bladder and sphincter behaviour on the basis of clinical somatic neurological deficits[5,6]. 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. The principal goals of managing NB are to preserve renal function and to maintain patient's quality of life (QoL) by decreasing urological complications. With a proper bladder management method that optimises 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 clean intermittent catheterisation (CIC) or the insertion of endourethral prosthetic devices[7,8].

Table 1: *Population Distribution*

Variables		Rehabilitated (n=15)	Non-rehabilitated (n=15)	Total	
Age (yr)	15 - 25	3 (10%)	4 (13.33%)	07(23.3%)	30
	26 – 40	10 (33.33%)	8 (26.66%)	18(60%)	
	41 - 60	2 (6.66%)	3 (10%)	05(16.7%)	
Sex	Male	14 (46.66%)	12 (30%)	26(86.7%)	30
	Female	1 (3.33%)	3 (10%)	04(13.3%)	
Cause	RTA	9 (30%)	6 (20%)	15(50%)	30
	Fall from height	4 (13.33%)	3 (10%)	07(23.3%)	
	Slipped	2 (6.66%)	2 (6.66%)	04(13.3%)	
	Violence	0	4 (13.33%)	04(13.3%)	
Occupation	Daily labour	4 (13.33%)	3 (10%)	07(23.3%)	30
	Student	2 (6.66%)	4 (13.33%)	06(20.0%)	
	Business	2 (6.66%)	3 (10%)	05(16.6%)	
	Farmer	2 (6.66%)	1 (3.33%)	03(10.0%)	
	Unemployed	2 (6.66%)	0	02(6.6%)	
	Housewife	0	2(6.66%)	02(6.6%)	
	Others	3 (10%)	2 (6.66%)	05(16.6%)	

Table 2: *Level of Injury and Urodynamic Findings*

Level of Injury (No. of patients)		UMN type bladder		LMN type bladder areflexia (%)	Normal
		Detrusor hyper-reflexia with DSD (%)	Detrusor hyper-reflexia without DSD (%)		
Suprasacral spinal	Cervical (4)	4 (13.33)	×	×	×
	Thoracic (12)	11 (36.66)	1 (3.33)	×	×
	Lumbar (6)	2 (6.66)	×	4 (13.33)	×
Sacral (8)		×	1 (3.33)	7 (23.33)	×

Though the study was not intended to see the incidence or prevalence of SCI, we have shown here simply to highlight its correlation with the international data. According to the NSCISC, the incidence rates are lowest for the paediatric age group and increase with age with the average age of 40.2 at the time of injury[2]. In our study majority of the cases belonged to age group 26 to 40 (59%) followed by the age group 15 to 25 (22%). The proportion of men in the NSCISC database is 80.8% making a gender ratio of 4.2:1. In our study male patients comprised 86.7% making a gender ratio of 6.5:1.

Natures of cause of SCI as per NSCISC database are many in which the motor vehicle crashes rank first (41.3%), followed by falls (27.3%), violence (primarily gun shoot wounds) (15.0%), sports injury (7.9%), and others (8.5%) including hit by a falling objects, medical or surgical complications, pedestrians being stuck by motor vehicles, stab wounds, bicycle mishaps, and violent personal contacts etc. In our study majority of the cases were due to road traffic accident (50.0%), followed by fall from height (23.3%), slipped (13.3%) and violence (13.3%).

In our study most of the patients belonged to daily labour comprising 23.3% followed by students (20%) and business persons (16.6%). Farmers constitute about 10.0%. Housewives and unemployed persons constitute 13.2% (6.6% each) and others 7 % (include driver, sports person etc.)

There is always controversy of using antibiotics as prophylaxis during urodynamic study. Some studies do not favour of giving antibiotic but most of the studies recommend antibiotic prophylaxis. Quek and Tay[9], 2004, in their study of 93 patients (44 males and 49 females) found that significant bacteriuria after urodynamic pressure flow study is largely asymptomatic and self-resolving. There was extremely low rate of symptomatic infection and hence antibiotic prophylaxis was not recommended[9].

Many of the studies recommend use of antibiotic. Pannek and Nehiba[10] 2007, Latthe *et al*[11] 2008, Bergman and McCarthy[12] 1983, Kartal *et al*[13] 2006 are in favour of antibiotic use before or after UDS. In our study we use ciprofloxacin 500mg two times daily for 3 days.

In our study we could see that some of the bladders behave in contrary to prediction from the level of spinal injury. Four (13.33%) of the 22 suprasacral spinal injury show hyporeflexic/areflexic bladder and one (3.33%) of the 8 sacral spinal injury show detrusor hyper-reflexia without DSD. Similar findings were seen by Kaplan *et al*[14] 1999 where 20 of 117 cervical cord lesions had

Table 3: *Distribution of Neurogenic Bladder to Rehabilitated or Non-rehabilitated*

Patients	Types of Bladder		Total
	Upper motor neurone	Lower motor neurone	
Rehabilitated	9	6	15
Non-rehabilitated	10	5	15
Total	19	11	30

Table 4: *Unparied Student's Test*

Urodynamic Study variables	UMN type bladder			LMN type bladder		
	Rehabilitated (mean)	Non-rehabilitated (mean)	p-value	Rehabilitated (mean)	Non-rehabilitated (mean)	p-value
Max. cystometric capacity	524.55 ± 183.01	340.80 ±118.90	p=0.018	511.00±79.78	306.00±70.71	p=0.018
Compliance	15.17±10.05	5.39±2.7	p = 0.012	15.92±9.90	3.9±2.5	p=0.168
Pdet. at first desire to void	24.89±23.86	51.89±23.86	p = 0.010	25.4±29.91	51.00±18.38	p=0.324
Pdet. at max. cyst. capacity	40.78±25.95	67.40±15.59	p= 0.014	38.83±30.33	65.00±15.56	p=0.302
Vol. at the first desire to void	294.78±149.45	251.56±80.45	p=0.45	314.2±58.22	247.50±23.33	p=0.194

areflexia, 26 of 84 sacral cord had either detrusor hyper-reflexia or detrusor-external sphincter dyssynergia. Light and Beric[15] 1992 explained the unexpected bladder behaviour in high spinal cord injury to be suspicion of associated lesion or dysfunction of sacral cord. Such poor correlation between physical finding and level of injury is also shown in many other studies[5,6].

Literature shows limited evidence on similar study that compares the different variables of UDS in a rehabilitated and non-rehabilitated NB. In a prospective study by Khanna *et al*[16] 2009, 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. In our study significant changes occur in the max. cystometric capacity, compliance, Pdet. at first desire to void, and Pdet. at max. cystometric capacity in UMN type of bladder but insignificant correlation in volume at the first desire to void after rehabilitation. During the graphical analysis we also found that there were significant reductions in the involuntary contractions (detrusor hyper-reflexia), not amounting to leakage, which occurs during the filling cystometry. It cannot be quantify in numeric.

In similar comparison of the LMN type bladders, significant correlation could be found only in the max. cystometric capacity. Other variables like compliance, volume at first desire to void, Pdet. at first desire to void, and Pdet. at max. cystometric capacity were found insignificant.

Conclusion:

The change in the nature of the NB after rehabilitation is different with the different types of bladder and not all variables of the cystometry changes significantly after rehabilitation. The study population in the present study is small and may require further study with a larger population.

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