

ORIGINAL RESEARCH

**A STUDY ON NEUROGENIC BLADDER ON SURGICAL
MANAGEMENT AND FOLLOW UP**

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ABSTRACT

Background: This study was done with an aim to evaluate the usefulness of non-surgical management, compliance to clean intermittent catheterization, and follow up in children suffering with neurogenic bladder.

Materials and Methods: It was an observational study conducted at Department of paediatric surgery, Niloufer hospital for woman and child health, Hyderabad. Duration of the study 4 months extending from October 2016 to September 2018. Children between 3-12 years presenting to the department of pediatric surgery with complaints of dribbling of urine and other lower urinary tract symptoms with congenital neural tube defects like sacral agenesis or meningocele/ meningomyelocele/ lipomenigocele or tethered cord syndrome.

Results: NBSD is more commonly seen in male children. NBSD in patients with MMC presents earlier compared to other cases. Diagnosis of NBSD is obvious as most of these cases have a past history of surgical intervention. Renal functions were normal in most of the children with NBSD. VUR in patients with NSBD improved in significant number of cases with non-surgical management. Scarring on DMSA is commonly seen in patients of NBSD associated with VUR. The renal function as assessed by DMSA improved in 1/3rd of patients after non-surgical management.

Conclusion: Most of the patients with NBSD have abnormal UDS findings. Bladder compliance improved in 41.9% of the cases and end filling pressures improved in 50% of cases by non-surgical management.

Keywords: NBSD, UDS, VUR, DMSA, Surgical Management.

INTRODUCTION

The urinary bladder is a unique organ. It demonstrates a remarkable integration of neuromuscular, mechanical, and physical properties that are crucial for its normal function. The bladder is the only autonomic organ under voluntary control.^[1] A normal urinary bladder has two functions. They are urinary storage at low pressure and urinary release through low resistance. Disorders of bladder function can range from problem of dysfunctional voiding to complex disorders involving neuropathic bladder dysfunction. An understanding of the normal process of urinary storage and drainage provides foundation for the evaluation and treatment of congenital and acquired abnormalities of storage and emptying. Under normal circumstances, all portions of the lower urinary tract (detrusor, bladder neck and external sphincter mechanism) function as a coordinated fashion for adequate storage and effective evacuation of urine. When a neurological lesion exists, these components fail to act as a unit.^[2-5] Neurogenic bladder dysfunction (NBD) is the term that summarizes all forms of bladder dysfunction, resulting in urinary retention or incontinence or combination of both. Neurologic lesions that affect lower urinary tract function constitute at least 25% of the severe clinical problems in pediatric urology. Neurogenic bladder can be a devastating condition. It causes a significant risk for urinary tract infections (UTIs), renal scarring, renal failure, vesicoureteral reflux, and incontinence. The management requires great responsibility and attentiveness by the patient, family, and treating physician.^[6,7] Achieving continence, ensuring storage and protecting the upper urinary tract remain the major goals in the management of neurogenic bladder dysfunction patients. The management includes both medical and surgical options. A surgical option is typically considered when there is failure of medical treatment to achieve above said goals. Clean intermittent catheterization (CIC) is one of the cornerstones in the medical management of NBD.^[1] As Department of pediatric surgery, Niloufer hospital is one of the referral centers for pediatrics and pediatric surgery in south India, we come across with considerable number of cases of neurogenic bladder with different etiologies like meningomyelocele, sacral agenesis, anorectal malformations, and other conditions where pelvic surgeries are done. These patients present with different problems due to inherent nature of the disease process or as a post-operative complication to the pelvic surgery which include the neurogenic bladder. This has aroused interest for considering a study on the management of the neurogenic bladder especially non-surgical management and its follow-up.

Aims and objectives

Aim: This study was done with an aim to evaluate the usefulness of non-surgical management, compliance to clean intermittent catheterization, and follow up in children suffering with neurogenic bladder.

Objectives:

- 1) To identify new cases early
- 2) Introduction of CIC or/and medications
- 3) Follow up.

MATERIALS & METHODS

Study design: observational study

Place of study: department of pediatric surgery, Niloufer hospital for woman and child health, Hyderabad.

Duration of study: 24 months extending from October 2016 to September 2018.

Inclusion criteria: children between 3-12 years presenting to the department of pediatric surgery with complaints of dribbling of urine and other lower urinary tract symptoms with congenital neural tube defects like sacral agenesis or meningocele/ meningomyelocele/ lipomeningocele or tethered cord syndrome.

Exclusion criteria:

- a. Children of age less than 3 years or more than 12 years
- b. Children with abnormal anatomy of KUB like posterior urethral valve, ectopic ureters with duplex moiety.
- c. Traumatic causes
- d. Cord compression due to tumors.
- e. Cases of cerebral palsy.
- f. Medical conditions like transverse myelitis.
- g. Cases that are lost to follow up or who have not completed 2 years of follow up.

Statistical analysis: MS OFFICE 2007, paired t test.

Study tool: case sheet Proforma and data collected by history and investigations.

Methodology: Voiding diary evaluates urinary incontinence in LUTS patients. It is well accepted in NBD that it is used as a primary or secondary outcome parameter by most physicians in the evaluation of therapy used for urinary incontinence. Voiding diary has following components.

1. Micturition time chart
2. Frequency volume chart
3. Bladder diary

Micturition time chart: includes only frequency voiding and incontinence episodes (diurnal and nocturnal).

Frequency volume chart includes frequency of voiding and voided volumes.

Bladder diary includes frequency of voiding and incontinence episodes (diurnal and nocturnal), voided volumes, type and quantity of volume intake.

Factors influencing voiding diary include: quantity of fluid intake, environmental temperature, type of fluid consumed, physical activity and convenience of toileting facilities.

Lengths of voiding diaries - 3 day diary.

Catheterization diary: The parameter recorded on catheterization diary includes the volume of urine obtained at catheterization, volume obtained in between catheterization. In neurogenic population with preserved sensation urgency episodes were also recorded. Comparison of catheterized volume to the volume obtained during pressure flow study of Urodynamic exam especially in patients with impaired bladder compliance may be very useful in assessing prognosis and directing therapy.

Utility of voiding diary: diagnostic, prognostic and therapeutic.

Diagnostic: Reliable in diagnosing urgency, urge incontinence and frequency. Unfortunately to the date no information on the reliability of voiding diary in the neurogenic incontinence has been published.

Prognostic: studies suggested that maximum voiding volumes correlate well with cystometric capacity during UDS. In neurogenic bladder the catheterization/ voiding diary is essential. If a voiding/ catheterization diary is suggestive of that a patient does not reach volumes, where measured UDS compliance becomes dangerous that the prognosis for the renal function is probably good.

Therapeutic: voiding diary is an excellent tool in helping to identify dietary bladder irritants, abnormal volume intakes or an abnormal voiding interval. These symptoms can be successfully treated with behavioral modifications. Voiding diary not only assists clinician in the assessment of LUTS but also permit the effectiveness of treatment such as behavioral therapy, oral medication, sacral nerve stimulation or botulinum toxin- A injection. Clinically a base line diary as compared to the subsequent voiding diary following initiation of therapy is often helpful in quantifying the success of therapy.

Urodynamic study: All the children were subjected to Urodynamic study during the evaluation period at the initial presentation, at 1 year and at 2 years following initiation of management.

During Urodynamic study the following parameters were recorded.

1. Urinary flow and residual urine
2. Cystometry
3. Electromyography
4. Videourodynamic study

RESULTS

A total of 59 cases were registered during the study period who presented with lower urinary tract symptoms. Among the 59 cases 28 cases were excluded from the study as 20 were having abnormal anatomy of KUB (6 cases with residual posterior urethral valves, 4 cases with valve bladder syndrome and 2 cases with VURD and 8 cases were diagnosed with ectopic ureter ± duplex moiety) and 3 cases of age less than 3 years. 5 cases lost to follow up during the study. In the present group of 31 cases, 13 cases were known cases of anorectal malformation and they were associated with sacral agenesis. 11 cases were known cases of neural tube defects (i.e meningomyelocele, lipomeningocele, or tethered cord syndrome). In the remaining cases 7 cases cause is not known. Cases having detrusor overactivity or detrusor sphincter dyssynergia at initial evaluation were treated with CIC along with anticholinergic medication (oxybutynin). Cases with detrusor hypoactivity or acontractile bladder at initial presentation were managed with CIC only. p value was calculated where feasible to know the statistical significance. A p value of 0.05 or less was considered significant. Sex distribution: Among the 31 cases included into the study 19 cases were male children and 12 cases were female children. There is a male preponderance of 1.58:1 in the present study.

Table 1: Sex of the patients

Sex	N
Male	19
Female	12
Total	31

The age range of children included in the present study was 3- 12 years. The most common age group of children affected was <6 years (22 out of 31 cases). When the average was taken, it was 5.96 years among total children. The average of male children presented was 5.87 years and of female children was 6.04 years. As there were different clinical diagnoses involved, the average age of presentation among children with different clinical diagnoses were measured and the findings were as follows. Children with sacral agenesis ± ARM was 7.48 years (male 6.75 and female 8.20 years). Children with post MMC/ lipomeningocele repair were 4.37 years (male = 4.36 years and female 4.38). This might represent that, the children who were diagnosed with MMC/ lipomeningocele repair presented early as the parents were counseled regarding consequences of the disease process and the surgery post operatively. There was another group of children with no past surgical history. The average age of children presented in this group was 5.71 yrs (male = 6.75 and female = 5.87 years)

Parents/ care givers educational status: among the 31 cases presented, children with uneducated parents were 15 and children with educated parents were 16.

Presenting complaints: children presented with different complaints pertaining to lower urinary tract. The most common presentation was dribbling of urine during both day and night or dribbling of urine with either constipation or stool incontinence. 11 cases presented with dribbling of urine, 11 cases presented with dribbling of urine and stool incontinence, 7 cases presented with dribbling of urine and constipation, and 2 cases presented with dysuria and pain abdomen/ pyuria.

Table 2: Presentation

S nO	Presentation	N
1	Dribbling of Urine	11
2	Dribbling of Urine And Stool Incontinence	11
3	Dribbling of Urine And Constipation	7
4	Others	2

Past surgical history: Among the 31 cases 13 children underwent some form of surgery for anorectal malformation (with cloaca in some cases) like PSARP/ PSVUAP/ abdomino PSARP. 11 children underwent surgery for MMC/ Lipomeningocele/ tethered cord. 2 children of MMC were placed ventriculo-peritoneal shunt for associated hydrocephalus. Child underwent peritoneal dialysis for raised serum creatinine prior to including in to the study. 6 children did not undergo any surgical procedure.

Table 3: History of the Past surgery

History of Past Surgery	n
Surgery for Arm/ Cloaca	13
Mmc Repair	11
Others	1
Nil	6
Total	31

Examination of body systems like CVS, CNS, lungs was normal among all children. Bladder was palpable in 4 cases during per abdomen examination. Average of height attained by male children was 103.57 and in female children were 105.84.

The average age at which the children were started first on CIC was 70.09 months. If we split the children into two groups of less than 6 years and more than 6 years, 22 children were started on CIC in less than 6 years and 9. Children after 6 years. All the children were subjected to complete urine examination and urine culture and sensitivity at regular intervals following introduction of CIC like that of serum creatinine measurement. There was pyuria and positive bacterial growth on urine culture among 1 child at 3months and at 6 months of follow up where as the number increased to 4 children at 1 and decreased to 2 cases by the end of 2 years of follow up. Common bacteriae grown on urinary cultures were E.coli followed by Klebsiella and Pseudomonas. Pyuria with no bacterial growth was noted in 7 children at 3 months, 9 children at 6 mo, 9 children at 1 year and 13 children at 2 years of follow up respectively.

Table 4: CIS VS UTI

Report	At 3 Months of Follow Up	At 6 Months of Follow Up	At 1 Year of Follow Up	At 2years of Follow Up
Pyuria With Bacterial Growth	1	1	4	2
Pyuria With No Bacterial Growth	7	9	9	13
Normal Study	23	21	18	16

There was neither pyuria nor positive bacterial growth in the cultures among 23 patients at 3 months, 21 patients at 6 months, 18 patients at 1 year and 16 patients at 2 years of follow up. There was an increased incidence of sterile pyuria compared at 3 months of follow up to 2 years of follow up in the present study.

The serum creatinine levels were measured in mg/dl at regular intervals for every patient i.e at initial presentation, at 3 months, 6 months, at 1 year and at 2 years of follow up. The average of serum creatinine values were calculated and the values include, 0.762 at initial presentation, 0.696 at 3 months of follow up, 0.761 at 6 months of follow up, 0.638 at 1 year of follow up and 0.580 at 2 years of follow up. There was a fall of 0.189 mg/dl (% of fall = 24.58%) at the end of 2 years of follow up. (p value =0.049)

Table 5: Serum Creatinine

Initial Presentation	At 3 Months	At 6 Months	At 1 Yr	At 2 Yr
0.762	0.696	0.761	0.638	0.58

p = 0.049 (paired t test)

Below table represents findings of ultrasound examination of kidney and urinary bladder at regular interval. The most common finding at initial presentation was irregular bladder wall or distended bladder with significant post void urine followed by hydroureteronephrosis (either unilateral or bilateral). Only 6 patients showed normal study. Findings at 6 months of follow up include, 10 cases were found to be having irregular bladder or distended bladder, 10 cases were identified with HUN (either bilateral or unilateral), 15 cases with significant post void residue, 3 cases with minimal post void residue and 6 patients with normal study. At 1 year of follow up 11 cases showed normal study, 9 cases with HUN (either bilateral or unilateral), 3 cases with significant post void residue and 13 cases with minimal post void residue. The findings at 2 years of follow up showed normal study in 17 cases, hydroureteronephrosis in 5 cases and minimal post void residue in 10 cases. Over all, normal findings were noted from 6 cases at initial presentation to 17 cases at 2 years of follow up.

Table 6: USG KUB

Parameter	Initial Presentation	At 3Months	At 6 Months	At 1 Yr	At 2 Yr
Normal Study	6	5	6	11	17
IB/DB	14	12	10	0	0
B/L HUN	6	6	6	2	1
U/L HUN	5	6	4	7	4
SPoU	14	21	15	3	3
MPoU	0	0	3	13	10

Micturition cystourethrogram was done in all cases at initial presentation, at follow up of 3 months, 6 months, 1 year and 2 years respectively. The most common initial presentation was irregular bladder (27 cases). VUR is noted among 17 cases (9 cases b/l and 8 cases u/l). Diverticulations were noted among 3 cases. During the course of follow up number of cases with irregular bladder was decreased from 27 at initial presentation to 26 at 3 months, 24 at 6 months, 10 at 1 year and 5 at 2nd year of follow up. At the same time, the number of cases showed regular bladder contour increased from 4 cases at the initial presentation to 5 cases at 3rd month, 7 cases at 6th month, 21 cases at 1 year and 26 cases after 2 years of follow up. Cases of bilateral VUR decreased from 9 at the initial presentation to 2 cases after 2 years of follow up and cases of unilateral VUR were 8 at the initial presentation and remained the same after 2 years of follow up. There was a significant conversion of cases of bilateral VUR to unilateral VUR and unilateral VUR to normal. The cases of VUR improved were those presented with less than grade IV/V VUR at initial presentation.

Table 7: VCUG

Parameter		Initial Presentati On	At 3 Month S	At 6 Month S	At 1 Yr	At 2 Yr
Irregular Bladder Wall		27	26	24	10	5
Regular Bladder Wall		4	5	7	21	26
B/L VUR		9	6	5	3	2
U/L VUR		8	8	9	8	8
Grade Of Vur	V	9	9	9	7	7
	<V	9	9	8	8	7
Diverticulations		3	3	4	3	2

Radionuclide scintigraphy was done as a part of evaluation and follow up for the study group. Photopenic areas (scars) were identified by scintigraphy in 3 patients at initial presentation and the number increased to 4 cases in the follow up with conservative management. 6 cases presented with compromised renal function at initial evaluation which reduced to 4 cases after 2 years of follow up. One case was presented with congenital left renal agenesis where as one more case has become nonfunctioning during the follow up.

Table 8: UDS

Finding	Initial Visit	At 6 Mo Follow Up	At 2 Y Follow up
Detrusor Over Activity	24	25	6
Detrusor Under Activity	5	3	1
DSD	2	1	0
Reduced Compliance	17	11	4
Unsafe End Filling Pressures	4	5	2

DISCUSSION

Neurogenic bladder is a clinical presentation of different etiological conditions. It can cause severe and irreversible damage to upper urinary tract and there are many studies supporting that early institution of treatment plan will protect the upper tract over a long term. The present study was an observational study conducted at Niloufer institute for women and child health, Hyderabad for a period of 2 years extending from October 2016 to September 2018. Vast majority of knowledge about neurogenic bladder management came from long term experience with MMC which is the most common neural defect. There is good evidence that if the management decisions were made during infancy, this will prevent both renal damage and the surrounding bladder wall changes, potentially impacting long term outcomes for renal function and safe urinary continence. The present study evaluated the non-surgical management of NSBD and its follow up over a period of 2 years. The improvements/deterioration of upper tracts and bladder was observed by serial examination of serum creatinine values, ultrasound examination of KUB, micturition cystourethrogram,

radionuclide scintigraphy and Urodynamic studies. Male children were the most effected group in the present study with 1.58:1 male to female preponderance. This distribution reflects the sex distribution according to etiological cause. A study by Ratan et al,^[1] (2004) from India has shown that the children with high ARM with associated anomalies was 4 times common in male children. In the present study neurogenic bladder due to vertebral anomalies associated with high ARM showed a sex ratio of 1.6:1 indicating a male preponderance. The studies done by Viswanath S et al,^[2] (2015) from Karnataka India, Raj kumar et al,^[3] from SGPGI Luknow on spinal dysraphism have shown a male preponderance of 1.78:1 and 1.5:1 respectively. Our present study also showed a male preponderance of 1.75:1. The age of presentation varies significantly depending on the etiology of the neurogenic bladder. Children suffering with spinal dysraphism presented early compared to the children with sacral agenesis associated with anorectal malformation. The present study also showed that the average age of presentation was 7.48 years. The average age of presentation of children with spinal dysraphism in the present study was 4.37 years which was nearly 3 years earlier to the sacral agenesis group. This early presentation was supported by Vishwanath S et al,^[2] study where the common age of presentation was less than 5 years. When compared to the studies conducted in the developed nations the presentation was albeit late. This difference may be due to the fact that our nation is a developing nation and poor educational status of the parents. There were studies concluding that early age of presentation was associated with better outcomes compared to those presented late (Jacob Kurian et al^[4]). Adherence to CIC is one of the major factors which may affect the outcome of the study. Adherence is defined by the world health organization as the extent of which a person's behavior corresponds with agreed recommendations from a health care professional.^[5] Loss of adherence may lead to damage to the upper urinary tract protection of which was a prime concern in the management. In a study conducted by Girotti et al,^[6] from Brazil over 60 patients on CIC for neurogenic and non-neurogenic bladders, the rate of adherence at 6 months was 61.7% and by the end of one year it decreased to 58%. Adherence rate was higher in women and in patients of >40 years. Neurogenic bladder patients have higher rate of adherence. Patients that adhere to CIC program had a significant higher score in psychological and social relationship domains. The factors enumerated for loss of adherence were pain during the procedure, urinary infection, costs, urethral injury, and patients/ parent's ability and some degree of cognition. Educational status of parents or care givers did not have any impact on adherence to CIC. In the present study parents of 16 children were educated beyond primary schooling and parents of 15 children were either uneducated or did not complete primary schooling. The study outcomes at the end of two years in terms of UTI, improvements in ultrasonography and other studies were unrelated to the educational status of the parents. All the parents in the present study accepted complete adherence to the CIC program. In a study conducted by Sexton et al,^[7] loss of adherence to anticholinergic medication in overactive bladders during the first 3 months ranged from 4-31%. This continued to rise over a time. The reason explained for this trend was higher dose of medication associated with adverse reactions. They also concluded that the newer anticholinergics had similar rates of overall discontinuation compared to the older formulations. In another study by Alsaleh et al,^[8] from Saudi Arabia in patients with spinal cord injury, the discontinuation rate of CIC was nearly 25% (11 out of 41 cases) by the end of 3 months of follow up. The reason of this loss of

adherence was due to lack of accessibility and financial support to buy catheters. Patients of neurogenic bladder present with lower urinary tract symptomatology (frequency, urgency, intermittency, and incontinence) and symptoms of bowel dysfunction (constipation/ stool incontinence) as described elsewhere. They may also present with recurrent UTI, pain abdomen and rarely with compromised renal function (anemia, reduced height or uremia). In the present study also the most common presentation was lower urinary symptoms (29 out of 31 cases). 93.5% of the cases presented with urinary incontinence. This symptom is associated with the bowel symptoms in nearly 71% of cases (either constipation or incontinence to stools). The incontinence was pseudo-incontinence in some cases. The clinical diagnosis was obvious in most of the cases by the time of presentation like known cases of MMC repair/ surgery for lipomeningocele or tethered cord syndrome/ sacral agenesis associated with ARM. Spinal dysraphism is the most common studied group in the evaluation of neurogenic bladder followed by caudal regression syndrome/ sacral agenesis. In the presented study also the common etiology was MMC (11 out of 31 cases)/ sacral agenesis (13 out of 31 cases) but the number of cases with sacral agenesis was more compared with the MMC cases. The reasons for this trend may be 3 fold; first, the number of cases presenting with MMC or other spinal dysraphisms was drastically reduced worldwide following folic acid supplementation during pregnancy.^[9] Secondly, most of the cases were referred to the other allied surgical specialty i.e neurosurgery for the management of neural tube defects. These patients were on follow up with neurosurgery department. Thirdly the population group presenting to our institute may not represent entire population as many of the cases were dealt by other institutes surrounding the geographic area. Interestingly there was another group (7 out of 31 cases) in the present study presented with LUTS where the etiological diagnosis was not made. These patients were evaluated with UDS and neurogenic element was diagnosed. This group of patients presented late and the prognosis was good with non-surgical management by the end of 2 years of follow up. Urinary tract infection was one of the prime concerns in patients managed with CIC. Studies report that there was a very high incidence of pyuria. Use of antimicrobial prophylaxis and other conventional therapies like cranberry juice have been studied in reducing the rate of bacteriuria. In a study by Foster et al,^[10] (2018), they concluded that the urinary cultures were positive even without pyuria or positive leucocyte esterase in patients treated with CIC for neurogenic bladder. *Proteus* was found to be associated with positive pyuria and positive leucocyte esterase. In a study by Schlager et al,^[11] (1999) they studied the effect of cranberry juice supplementation instead of antibacterial prophylaxis. They proposed that the cranberry juice causes urinary acidification as a result of hippuric acid excretion thus causing antibacterial effect, increased fluid volume causes washout of bacteria from bladder. They concluded that use of sterile catheter did not decrease the incidence of bacteriuria. In a study by et al Maynard et al,^[12] to identify the risk factors associated with febrile bacterial UTI, they concluded that decreased bladder compliance (<10ml// cm of H₂O), detrusor over activity, trabeculations in the bladder and presence of VUR were associated with high incidence of bacteriuria. In a study by Maynard et al,^[12] (1984) use of antibiotic prophylaxis has significantly reduced the probability of laboratory infection (positive cultures) but not the clinical infection (pyuria). Similar findings were concluded in another study by Elliot et al,^[13] (2005). In the present study also all patients underwent urinary examination with cultures at regular intervals and all patients were

kept on prophylactic antimicrobial (1/3 dose of therapeutic dose). Patients were grouped as with normal examination and cultures, pyuria with no bacterial growth over cultures and pyuria with positive bacterial growths. There was a significant increase in the cases with pyuria with or without bacterial growths at the end of 2 years of follow up and the number gradually increased from 3 months of follow up to 2 years of follow up. Common bacteria grown on cultures was E.coli followed by Klebsiella in the present study. These findings correlate with conclusions of above studies. Baseline serum creatinine values were calculated as a part of evaluation and at regular follow up. In a study conducted by Cho et al,^[14] (2016) the median serum creatinine value was 0.4mg/dl which represented normal levels. In the present study also the serum creatinine values were normal for their age in 87% of the cases (27 cases out of 31 cases). Only 3 cases presented with elevated levels of serum creatinine values ranging from 1.9 to 2.7 mg/dl. All of these cases presented with compromised renal function at the time of presentation. The values came down to normal values in two cases after initiation of conservative management and for a follow up of 2 years. The other case in which values remained high was on regular follow up with the department of nephrology. He was managed with hemodialysis on two occasions during the follow up. The mean value of serum creatinine value in the present study was 0.762 mg/dl at initial presentation which is well within normal levels. The number of cases presented with significant post void residue came down from 14 out of 31 cases at initial evaluation to 3 out of 31 cases by 2 years. There was a significant conversion of bilateral HUN cases to unilateral HUN (3 out of 6 cases). 4 out of 5 unilateral HUN cases improved to normal at the end of study. Normal findings were observed in 6 cases at initial presentation which improved to 17 cases by the end of 2 years. With the above findings in the present study it can be concluded that ultrasonography is an important clinical tool in the assessment and follow up of these patients. Voiding/ micturiting cystourethrogram is one of the initial investigations in the evaluation of neurogenic bladder. The common findings were irregular bladder wall described elsewhere as Christmas tree pattern and associated vesicoureteric reflux. 87% of the cases (27 out of 31 cases) presented with irregular bladder wall in the initial evaluation and 55% of cases (17 out of 31 cases) presented with associated unilateral or bilateral reflux. 9 out of 17 cases of VUR were grade V. Nearly 80% of cases with irregular bladder improved by the end of the study (22 out of 27 cases). Similarly the number of cases identified with VUR has reduced from 17 cases to 10 cases out of 31 cases at the end of 2 years (23% improvement). It is observed that most of the VUR cases that improved were those belonging to <grade V VUR. In a study by Skoog et al,^[15] the rate of resolution of VUR on conservative management was 92% for grade I, 81% for grade II, 70% for grade III, 58% for grade IV and <20% for grade V over a period of 5 years of follow up. In another study by Smellie et al,^[16] 73% of cases with grade III/IV VUR cases were resolved over a period of 10 years. Soylu et al,^[17] (2008) predicted renal scarring in children with UTI and VUR. The relation of age, gender and grade of VUR were recorded over a period of 42.4± 35.7 months (range 4-165 months). They concluded that male sex, female children with age >27 months and VUR of ≥ grade IV/V were the risk factors for development of new renal scars. They also concluded that presence of renal scar prior to the initiation of therapy was an independent risk factor. In a study by Shiroyanagi et al,^[18] (2009) in long term follow up of children of age >10 years with DMSA scans among spina bifida cases, 25% had abnormal scans at initial presentation. Febrile UTI and VUR were known to

be associated with abnormal reports. Leonardo et al,^[19] studied renal scarring in children and adolescents with lower urinary tract symptoms. Renal scarring was seen in 31% of the cases. VUR, UTI, decreased bladder capacity, urinary residue, trabaculated and thick bladder wall were associated with renal scarring. Dik et al,^[20] (2006) concluded in their study that an early start of therapy with CIC and medications preserves renal function. DeLair et al,^[21] in their study on renal cortical deterioration in children with spinal dysraphism analyzed that VUR, female sex and delayed initiation of CIC were associated with increased risk of renal function loss. In the present study also detrusor pressure alterations were noted in all children. Reduced compliance of the bladder was recorded among 17/31 cases at initial presentation but it improved to 4/31 cases at the end of the study. Unsafe end filling pressure were also reduced from 4/31 cases to 2/31 cases at the end of the study period. The detrusor pressures were abnormal in 29/31 cases at initial presentation. This improved in 22/31 cases by the end.

CONCLUSION

1. NBSD is more commonly seen in male children.
2. NBSD in patients with MMC presents earlier compared to other cases.
3. NBSD commonly presents with LUTS which is usually associated with constipation.
4. Diagnosis of NBSD is obvious as most of these cases have a past history of surgical intervention.
5. Renal functions were normal in most of the children with NBSD.
6. VUR in patients with NSBD improved in significant number of cases with non-surgical management.
7. Scarring on DMSA is commonly seen in patients of NBSD associated with VUR. The renal function as assessed by DMSA improved in 1/3rd of patients after non-surgical management.
8. Most of the patients with NBSD have abnormal UDS findings. Bladder compliance improved in 41.9% of the cases and end filling pressures improved in 50% of cases by non-surgical management.

REFERENCES

1. Ratan SK, Rattan KN, Pandey RM, Mittal A, Mugu S, Sodhi PK (2004) Associated congenital anomalies in patients with Anorectal malformations – a need for developing uniformed practical approach. *J Pediatr surg* 39: 1706 – 1711.
2. Sidram V et al. A Prospective Study Of Spectrum Of Spinal Dysraphisms And Its Surgical Outcome. *J Spinal Surg* 2015;2(3):72-77
3. Kumar, R., & Singh, S. N. (2003). Spinal Dysraphism: Trends in Northern India. *Pediatric Neurosurgery*, 38(3), 133–145.
4. Kurian jj et al. encouraging results of bowela and baldder management in spina bifida aperta in South India with quaoity of life scores in a tertiary care institution in South India. *J Indian Assoc Pediatr Surg* 2019;24:21-6
5. Woodward S, Rew M: Patients' quality of life and clean intermittent self- catheterization. *Br J Nurs*. 2003; 12: 1066-74.
6. Girotti, M. E., MacCornick, S., Perissé, H., Batezini, N. S., & Almeida, F. G. (2011). Determining the variables associated to clean intermittent self-catheterization adherence

- rate: one-year follow-up study. *International Braz j Urol*, 37(6), 766–772. doi:10.1590/s1677- 55382011000600013
7. Sexton, C. C., Notte, S. M., Maroulis, C., Dmochowski, R. R., Cardozo, L., Subramanian, D., & Coyne, K. S. (2011). Persistence and adherence in the treatment of overactive bladder syndrome with anticholinergic therapy: a systematic review of the literature. *International Journal of Clinical Practice*, 65(5), 567–585.
 8. Anas Jehad AlSaleh, Ahmad Zaheer Qureshi, Zilal Syamsuddin Abdin & Ahmed Mushabbab AlHabter (2018): Long-term compliance with bladder management in patients with spinal cord injury: A Saudi- Arabian perspective, *The Journal of Spinal Cord Medicine*.
 9. Werler M, Shapiro S, Mitchell AA: Periconceptual folic acid exposure and risk of concurrent neural tube defects. *JAMA* 1993;10:1257– 1261.
 10. Forster CS, Shaikh N, Hoberman A, et al. Uropathogens and Pyuria in Children with Neurogenic Bladders. *Pediatrics*. 2018;141(5):e20173006.
 11. Schlager TA, Clark M, Anderson S. Effect of a single-use sterile catheter for each void on the frequency of bacteriuria in children with neurogenic bladder on intermittent catheterization for bladder emptying. *Pediatrics* 2001;108: E71.
 12. Elliott, s. P., villar, r., & duncan, b. (2005). Bacteriuria management and urological evaluation of patients with spina bifida and neurogenic bladder: a multicenter survey. *The journal of urology*, 173(1), 217–220.
 13. Cho, P. S., Bauer, S. B., Pennison, M., Rosoklija, I., Bellows, A. L., Logvinenko, T., Borer, J. G. (2016). Sacral agenesis and neurogenic bladder: Long-term outcomes of bladder and kidney function. *Journal of Pediatric Urology*, 12(3), 158.e1–158.e7.
 14. Ali, M. M., Ahmed, A.-F., Khaled, S. M., Abozeid, H., & AbdelMagid, M. E. (2015). Accuracy of ultrasound-measured bladder wall thickness for the diagnosis of detrusor overactivity. *African Journal of Urology*, 21(1), 25–29
 15. Smellie JM, Jodal U, Lax H et al. Outcome at 10 years of severe vesicoureteric reflux managed medically: report of the International Reflux Study in Children. *J Pediatr* 2001; 139:656–63
 16. Soyulu, A., Demir, B. K., Türkmen, M., Bekem, Ö. Saygı, M., Çakmakçı, H., & Kavukçu, S. (2008). Predictors of renal scar in children with urinary infection and vesicoureteral reflux. *Pediatric Nephrology*, 23(12), 2227–2232.
 17. Shiroyanagi, Y., Suzuki, M., Matsuno, D., & Yamazaki, Y. (2009). The Significance of 99mTechnetium Dimercapto-Succinic Acid Renal Scan in Children with Spina Bifida During Long-Term Followup. *The Journal of Urology*, 181(5), 2262–2266.
 18. Leonardo, C. R., Filgueiras, M. F. T., Vasconcelos, M. M., Vasconcelos, R., Marino, V. P., Pires, C., Lima, E. M. (2007). Risk factors for renal scarring in children and adolescents with lower urinary tract dysfunction. *Pediatric Nephrology*, 22(11), 1891–1896.
 19. Dik, P., Klijn, A. J., van Gool, J. D., de Jong-de Vos van Steenwijk, C.C. E., & de Jong, T. P. V. M. (2006). Early Start to Therapy Preserves Kidney Function in Spina Bifida Patients. *European Urology*, 49(5), 908–913.

20. Delair, S. M., Eandi, J., White, M. M., Nguyen, T., Stone, A. R., & Kurzrock, E. (2007). Renal Cortical Deterioration in Children with Spinal Dysraphism: Analysis of Risk Factors. *The Journal of Spinal Cord Medicine*, 30(sup1), S30–S34.
21. Cohen, R. A., Rushton, H. G., Belman, A. B., Kass, E. J., Majd, M., & Shaer, C. (1990). Renal Scarring and Vesicoureteral Reflux in Children with Myelodysplasia. *The Journal of Urology*, 144(2), 541–544.
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