Clinical Research

Characteristics of neurogenic lower urinary tract dysfunction patients at Cipto Mangunkusumo Hospital

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ABSTRACT

BACKGROUND Neurogenic lower urinary tract dysfunction (NLUTD) is an abnormal function of the bladder, urethra (and/or prostate in males) in patients with a clinically confirmed relevant neurologic disorder. Hence, accurate diagnosis and management of NLUTD is crucial. This study aimed to recognize the characteristics of NLUTD to identify, manage, and prevent the associated complications.

METHODS This retrospective study was conducted at the Outpatient Clinic of the Department of Urology, Cipto Mangunkusumo Hospital, Jakarta, Indonesia, from January 2011 to December 2021. The study analyzed data collected from voiding dysfunction patients with upper motor neurological disorders who underwent urodynamic studies during the study period. Incomplete data in the medical records were excluded.

RESULTS Mean age of the participants was 50.7 (18–95) years old. The most common cause of NLUTD was stroke (26.6%), followed by unspecified groups and spinal cord injury. Patients under 20 years old were affected by trauma and congenital defects. Of the patients, 34.0% had urinary retention, and 18.1% had incontinence. Small bladder capacity occurred in patients with stroke, Parkinson's disease, and spinal/cerebral tumors, leading to decreased bladder compliance.

CONCLUSIONS NLUTD was associated with aging, with upper motor neurological lesions such as trauma, stroke, and spinal/cerebral injury being the most common etiologies. Most patients with NLUTD had small bladder capacity and decreased compliance based on urodynamic result.

KEYWORDS nervous system diseases, population characteristics, urinary incontinence, urinary tract infection

According to the International Continence Society (ICS), neurogenic lower urinary tract dysfunction (NLUTD) is defined as an "abnormal or difficult function of the bladder, urethra (and/or prostate in men) in mature individuals in the context of clinically confirmed relevant neurologic disorder." NLUTD can lead to urinary tract problems, such as incontinence and infection, which greatly affect a person's quality of life.[1,2] Its most common etiologies include spinal cord injury (SCI) secondary to trauma-induced spinal column fractures, vascular ischemia, and infections. The incidence of NLUTD also increases in some neurological diseases affecting children and adults, such as multiple sclerosis, Parkinson's disease, stroke, and spina bifida.[3,4]

NLUTD is commonly diagnosed based on urodynamic examinations in high-risk patients; these examinations involve invasive or non-invasive assessments of lower urinary tract parameters regarding function and dysfunction. Invasive urodynamic investigations may be challenging in

patients with neurourological problems and require the evaluation of several technical sources of artifacts. Maintaining good urodynamic recordings and interpretation based on the good urodynamic practice guidelines by ICS is critical to determine the existence of a malfunction and comprehend its clinical ramifications in such a manner. Thus, non-invasive urodynamic investigations are more suitable for diagnosing NLUTD, with repeated studies performed in a single session aiding clinical decision-making and enabling significantly improved outcomes.[3]

To improve the diagnosis and management of NLUTD, exploring the characteristics of patients with NLUTD-associated neurological disorders is essential. However, studies on NLUTD have yet to be conducted in Indonesia. Therefore, this study aimed to evaluate the prevalence of NLUTD and the characteristics of affected patients (including clinical and urodynamic parameters) at a tertiary care center in Indonesia.

METHODS

This study was conducted at Cipto Mangunkusumo Hospital, a single tertiary care center in Indonesia. The medical records of patients with NLUTD who visited the outpatient clinic of the Department of Urology were evaluated retrospectively. Individual patient data were collected and reviewed through accidental sampling between 2011 and 2021. This study was approved by the institutional review board (No: KET-328/UN2.F1/ETIK/PPM.00.02/2022). Informed consent was not needed as this study used secondary data from medical records.

All patients with voiding dysfunction who had undergone a urodynamic study between January 2011 and December 2021 and had upper motor neurological disorders were included without any restrictions on age, sex, and other demographics. Patients with incomplete medical records were excluded. We assessed the patients' demographic data (age and sex), chief complaints, diagnoses of neurological disorders, and urodynamic findings obtained at the onset of neurological disease.

The symptom because of which the patient visited the urologist was considered the chief complaint and was evaluated based on storage and voiding symptoms. Neurological disorders were classified as cerebrovascular accidents, tumors, spinal cord surgery, SCI, Parkinson's disease, or spina bifida. Bowel problems were evaluated based on fecal incontinence or defecation problems, and male patients were assessed for sexual dysfunction (erectile dysfunction [ED] and retrograde ejaculation).

Urodynamic findings were obtained during the filling and voiding phases. Patients were evaluated for bladder capacity, bladder compliance, urodynamic stress incontinence (USI), detrusor overactivity (DO), and detrusor overactivity incontinence (DOI) during the filling phase, and for bladder outlet obstruction index (BOOI), detrusor underactivity (DU), acontractile bladder, and detrusor sphincter dyssynergia (DSD) during the voiding phase. Bladder capacity was categorized as small (<250 ml), normal (250–500 ml), or large (>500 ml).

Bladder compliance was determined by dividing the change in volume by the change in detrusor pressure (Pdet); it was classified as either normal (Pdet: 12.5–40 ml/cmH_2O) or low (end-filling Pdet ≥17.5 cmH_2O). Increased Pdet and poor urine flow during the voiding phase were considered indicative of BOO. In men, the BOOI was calculated using the following formula: BOOI = PdetQmax–2Qmax. BOOIs of <20, 20–40, and >40 indicated no obstruction, equivocal obstruction, and infravesical obstruction, respectively.[4] In women, BOO was diagnosed if the maximal flow rate (Qmax) was <12 ml/sec and the Pdet at Qmax (PdetQmax) was >20 cmH_2O.[5]

The bladder contractility index (BCI) was calculated to diagnose DU using the following formula: BCI = PdetQmax + 5Qmax. For both men and women, DU was defined by a BCI of <100, Qmax of 12 ml/sec, and PdetQmax of 10 cmH_2O.[6] An acontractile detrusor was indicated by undetectable bladder contraction during voiding.[7] DSD was referred to BOO caused by simultaneous detrusor muscle contraction and involuntary urethral sphincter activation.

Categorical data are presented as absolute values and percentages. Normally distributed data are presented as means and standard deviations, whereas non-normally distributed data are presented as medians and ranges.

RESULTS

A total of 1,351 patients underwent urodynamic examinations at the study center between January 2011 and December 2021. Among these, 35.1% had an underlying neurological disease, and 48.5% had already

Table 1. Characteristics of the patients

Variables	n (%) (N = 474)
Male sex	269 (56.8)
Bowel problems	193 (40.7)
Male sexual dysfunction	102 (37.9)
Duration of urological complaints (>1 years)	230 (48.5)
Age (years)	
≤20	74 (15.6)
21–30	62 (13.1)
31–40	50 (10.5)
41–50	45 (9.5)
51–60	65 (13.7)
>60	178 (37.6)
Neurological disease (n = 570)*	
Cerebrovascular accident	131 (26.6)
SCI	84 (17.0)
DM, n = 474	77 (16.2)
Spinal cord surgery	77 (15.6)
Medulla spinalis/cerebral tumor	33 (6.7)
HNP	18 (3.7)
Congenital disease	15 (3.2)
Parkinson's disease	10 (2.0)
Infection	10 (2.0)
Autoimmune disease	5 (1.0)
Others†	110 (22.4)
Complaints	
LUTS	182 (38.4)
Frequency	67 (14.1)
Hesitancy	31 (6.5)
Urgency	20 (4.2)
Incomplete emptying	18 (3.8)
Weak stream	17 (3.6)
Nocturia	12 (2.5)
Straining	9 (1.9)
Dribbling	8 (1.7)
Urinary retention	161 (34.0)
Urinary incontinence	86 (18.1)
Dysuria	10 (2.1)
Others†	35 (7.4)

DM=diabetes mellitus; LUTS=lower urinary tract symptoms; HNP=herniated nucleus pulposus; SCI=spinal cord injury
*Some patients had multiple diseases; †others were hypertension, low back pain, and history of seizure

experienced urological problems for over a year. The patient characteristics were relatively balanced between the sexes, with more males included in the present study. In the entire cohort, the proportion of patients aged >60 years was the highest, followed by that of patients aged ≤20 years, with the mean age of 50.7 (19.5) years (Table 1). Furthermore, 25%, 6%, and 4% of the patients had a history of alpha-blocker usage, electrical stimulation, and bladder training, respectively; these treatments were discontinued 1 week before the urodynamic examination.

The most common neurological disease was stroke (26.6%), followed by other diseases presented as "others" in Table 1. The most common symptom was LUTS (38.4%), followed by urinary retention (34.0%). Most patients with stroke had a small bladder capacity but normal bladder compliance. Only a few patients had DO, DOI, or USI (Table 2).

DISCUSSION

This study found that up to 35.1% of the patients with neurological diseases had NLUTD, emphasizing the importance of NLUTD screening in this patient population. The prevalence of NLUTD increases with age; while trauma, stroke, and spinal/cerebral injuries are the most common etiologies of upper motor neurological lesions. NLUTD has a relatively high prevalence and affects both men and women equally, as indicated by the present study. However, Hamid et al[8] reported a higher prevalence of NLUTD in women than in men, which could be because women are more likely to seek medical help than men.

To make therapeutic decisions and to effectively tailor the management of NLUTD, invasive urodynamic procedures are essential for identifying changes in bladder function; urodynamic findings may vary based on the culprit lesion location. A previous study found that after stroke, DO with unrestrained bladder contraction was the most common urodynamic finding (68–90%).[9] Conversely, the present study found DU to be the most common urodynamic finding based on the weak BCI results, suggesting the need for further investigation into lesion location and other underlying comorbidities to further understand the etiology of low bladder contractility, hence enabling early management. Lee et al[10] found that in patients with chronic pontine stroke, there was a greater frequency of DU, a lower

Table 2. Urodynamic findings according to clinical diagnosis (N = 570)

Urodynamic findings	Neurological diseases										
	Stroke, n (%) (N = 131)	Medulla spinalis/ cerebral umor, n (%) (N = 33)	SCI, n (%) (N = 84)	Parkinson's, n (%) (N = 10)	Spinal cord surgery, n (%) (N = 77)	HNP, n (%) (N = 18)	Congenital, n (%) (N = 15)	Infection, n (%) (N = 10)	Autoimmune, n (%) (N = 5)	DM, n (%) (N = 77)	Not otherwise specified, n (%) (N = 110)
Bladder capacity (ml)											
Small (<250)	64 (48.9)	17 (51.5)	40 (47.6)	6 (60.0)	37 (48.0)	11 (61.1)	10 (66.7)	4 (40.0)	2 (40.0)	33 (42.9)	62 (56.4)
Normal (250–500)	52 (39.7)	10 (30.3)	35 (41.7)	3 (30.0)	30 (39.0)	6 (33.3)	5 (33.3)	6 (60.0)	3 (60.0)	35 (45.4)	43 (39.1)
Large (>500)	15 (11.4)	6 (18.2)	9 (10.7)	1 (10.0)	10 (13.0)	1 (5.6)	0	0	0	9 (11.7)	5 (4.5)
Compliance											
Normal	55 (42.0)	5 (15.2)	25 (29.8)	3 (30.0)	22 (28.6)	0	0	0	0	26 (33.8)	37 (33.6)
Low	32 (24.0)	20 (60.6)	27 (32.1)	5 (50.0)	39 (50.6)	9 (50.0)	11 (73.3)	1 (10.0)	1 (20.0)	22 (28.6)	42 (38.2)
Increased	44 (34.6)	8 (24.2)	32 (38.1)	2 (20.0)	16 (20.8)	9 (50.0)	4 (26.7)	9 (90.0)	4 (80.0)	29 (37.7)	31 (28.2)
USI	4 (3.1)	5 (15.2)	10 (11.9)	1 (10.0)	10 (13.0)	0	4 (26.7)	1 (10.0)	0	4 (5.2)	9 (8.2)
DO	19 (14.5)	13 (39.4)	22 (26.2)	1 (10.0)	24 (31.2)	4 (22.2)	8 (53.3)	6 (60.0)	0	14 (18.2)	26 (23.6)
DOI	9 (6.9)	5 (15.2)	13 (15.5)	1 (10.0)	15 (19.5)	1 (5.6)	5 (33.3)	1 (10.0)	0	4 (5.2)	9 (8.2)
BOOI											
Infravesical obstruction (>40)	41 (31.3)	11 (33.3)	17 (20.2)	0	17 (22.1)	6 (33.3)	10 (66.7)	2 (20.0)	1 (20.0)	22 (28.6)	34 (30.9)
Equivocally obstructed (20–40)	40 (30.5)	8 (24.2)	22 (26.2)	5 (50.0)	15 (19.5)	4 (22.2)	0	0	0	25 (32.5)	20 (18.2)
Unobstructed (<20)	50 (38.2)	14 (42.4)	45 (53.6)	5 (50.0)	45 (58.4)	8 (44.4)	5 (33.3)	8 (80.0)	4 (80.0)	30 (39.0)	56 (50.9)
BCI											
Strong (>150)	14 (10.7)	3 (9.1)	5. (6.0)	0	2 (2.6)	0	0	2 (20.0)	0	3 (3.9)	11 (10.0)
Normal (100–150)	25 (19.1)	3 (9.1)	16 (19.0)	0	9 (11.7)	7 (38.9)	2 (13.3)	3 (30.0)	4 (80.0)	8 (10.4)	25 (22.7)
Weak (<100)	92 (70.2)	27 (81.8)	63 (75.0)	10 (100.0)	66 (85.7)	11 (61.1)	13 (86.7)	5 (50.0)	1 (20.0)	66 (85.7)	74 (67.3)
DSD	2 (1.5)	0	1 (1.2)	1 (10.0)	0	0	0	0	0	3 (3.9)	4 (3.6)
Acontractile bladder	11 (8.4)	14 (42.4)	17 (20.2)	2 (20.0)	19 (24.7)	2 (11.1)	1 (9.1)	0	0	0	6 (5.5)

BCI=bladder contractility index; BOOI=bladder outlet obstruction index; DM=diabetes mellitus; DO=detrusor overactivity; DOI=detrusor overactivity incontinence; DSD=detrusor sphincter dyssynergia; HNP=herniated nucleus pulposus; SCI=spinal cord injury; USI=urodynamic stress incontinence

maximum detrusor pressure, and greater compliance, compared with patients with upper cervical SCI. Burney et al[11] further revealed that compared with patients with acute pontine infarction (lasting for <3 months), patients with chronic pontine infarction (lasting for >3 months) exhibited DU more frequently. Patients who have experienced a stroke may exhibit different urodynamic findings over time.

Based on the lesion level in patients with SCI in this study, neurogenic DO accounted for 95% of the storage abnormalities, and DU occurred in 83% of the cases. Kulaklı et al[12] found that traumatic brain injuries caused storage dysfunction (44%) and voiding dysfunction (38%). Regarding DU, it is theorized that severe neurological injury or disease disrupts efferent neuronal pathways. Notably, in this study, most patients with SCI had DU; 75.0% of the patients with SCI had a low BCI (similar to patients with stroke), with 70.2% exhibiting DU. Given that the S2–S4 segments of the sacral plexus control micturition, the urinary symptoms associated with SCI can be roughly divided into suprasacral, sacral, and infrasacral based on the level of injury. Suprasacral lesions (or upper motor neuron lesions) cause detrusor hyperactivity, leading to DO. Furthermore, individuals with lesions at or above this level may develop a neurogenic acontractile detrusor. The detrusor muscle and external sphincter show simultaneous hyperactivity in LUTD. The type of bladder dysfunction that develops after a spinal shock is determined by the level of the cord lesion.[13] Unfortunately, data on the level of spinal cord lesions were unavailable at our center.

Patients with cervical or thoracic tumors or lesions of different etiologies frequently report urinary problems, which typically develop later and rarely present as the initial symptoms. In these patients, compared with storage symptoms, voiding symptoms are more common and appear earlier.[13] In this study, 15.2% of the patients presented with acontractile bladders from all etiologies. Poor flow and residual urine volumes are closely associated with detrusor areflexia during voiding. Detrusor hyperreflexia, often caused by lesions in the inhibitory centrifugal circuit of the detrusor or by irritation of the neural pathways within the spinal cord, was observed in 28% of the patients. Low bladder compliance is commonly observed in patients with conus medullaris and cauda equina injuries and is considered a sign of parasympathetic decentralization,[14] as observed in 61.1% of patients in the current study.

Spina bifida is the most common cause of NLUTD in children and adolescents, particularly in developing countries, and can cause bladder problems[3,15] of severity depending on the type of spina bifida. A herniated nucleus pulposus (HNP) can cause bowel and bladder problems in approximately 1% of patients and is associated with a poor prognosis.[16] Bartolin et al[17] reported that voiding difficulties and acontractile detrusors were present in 26% of cases; they also reported that DU was observed in up to 83% of cases of disc problems, such as HNP. Abnormal urodynamic examination findings are common in patients with lumbar disc degeneration, with detrusor areflexia being the most frequent finding along with a high percentage of voiding complaints. Electromyography can detect anomalies in perineal floor muscle innervation. Chronic nerve injuries can lead to detrusor atrophy and bladder sensitivity.[18]

Patients with spinal tuberculosis (TB) who experience LUTD may exhibit various detrusor functions, ranging from normal urodynamic findings to an areflexic bladder, DO, DO combined with DSD, and a variable Qmax. Interestingly, one study revealed that the level of spinal cord involvement observed on magnetic resonance imaging did not correspond with the urodynamic results; however, some individuals with spinal TB developed DO and DSD with poor bladder compliance.[19] In the present study, only a small proportion of the patients had DSD or DO; however, a majority of these presented with a decreased bladder compliance.

Approximately 16.2% of the patients in the current study had a history of diabetes, as opposed to the 8.3% observed in another study that revealed a lower global prevalence of NLUTD.[20] In 2019, Indonesia had around 10.7 million individuals with diabetes, making it one of the countries with the highest absolute prevalence of diabetes.[21] Notably, approximately 66% of patients with DU also have diabetes.[7] The most common urological complications of diabetes are urgency and incontinence, with hyposensitivity and DU potentially developing at a later stage. The classic symptoms of diabetic cystopathy include reduced bladder sensation, increased bladder capacity, and reduced bladder emptying with increased post-void residual volume.[22] However, the current study found that patients with diabetes exhibited a variety of urological dysfunctions,

such as an overactive bladder (18.2%), low bladder compliance (28.6%), and DSD (3.9%). Over half of these patients had a blocked bladder outlet, while 85.7% experienced weak contractions. These findings are similar to those of Kaplan et al,[23] who reported detrusor hyperreflexia and abnormal detrusor contractility in 55% and 23% of the patients, respectively. Detrusor hyperactivity may be a compensatory response to increased urine production in the early stages of diabetes. Chronic hyperglycemia leads to myogenic degeneration and sensory/autonomic diabetic nerve impairment, resulting in bladder decompensation (such as DU) in the later stages of diabetes, indicating that DO begins early in the disease.[23]

Patients with neurological disorders frequently experience bladder and bowel problems; men, in particular, also experience sexual dysfunction due to obstruction of the long spinal pathways between the brain and the sacral cord or the pelvic autonomic nerves, which interferes with genital swelling, erection, ejaculation, and orgasm due to motor and sensory control loss.[24,25] In this study, 40.7% of patients experienced bowel problems (such as incontinence or constipation), whereas 37.9% of male patients reported sexual dysfunction, with ED being the most common issue among men. Unfortunately, corresponding data in women were lacking because women are not routinely evaluated for sexual dysfunction at our center. Martinez et al[25] reported that ED, ejaculation dysfunction, and problems with sexual desires in young men could be caused by various neurological disorders, such as SCIs and degenerative diseases. The incidence of sexual dysfunction among men with NLUTD is as high as 80%, with symptoms varying depending on the etiology.

The limitation of this study was the retrospective design; thus, some data were missing from the databases. In conclusion, urodynamic examinations in this study showed that most patients with NLUTD had a small bladder capacity and decreased bladder compliance. Recognizing the characteristics of NLUTD and conducting regular urodynamic examinations allow for early detection and tailored management of the condition. These findings can also be the base of new scheme in the hospital to conduct urodynamic study in patients diagnosed with neurological disorders to diagnose bladder dysfunction earlier. This study can also emphasize the importance of NLUTD screening. In the future, a prospective multicenter study is required to evaluate NLUTD and its urodynamic outcomes.

Conflict of Interest

Harrina Erlianti Rahardjo is the editorial board member but was not involved in the review or decision making process of the article.

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