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Potential predictors of detrusor underactivity in a urology outpatient clinic: a 5-year single center experience study

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ABSTRACT

BACKGROUND Detrusor underactivity (DU) is diagnosed using urodynamics, which caused by a combination of strength and duration of the bladder muscle and resulted in prolonged bladder emptying. Invasive urodynamics, which are limited in many clinical settings, should be performed efficiently in high-risk patients to reduce the risk of emerging complications during and after the procedure. Therefore, this study was aimed to identify the potential predictors of DU for limited clinical settings.

METHODS This retrospective study was retrieved from the medical records of patients who underwent urodynamics in the Department of Urology, Cipto Mangunkusumo Hospital from 2015 to 2020. Age, sex, bladder capacity, bladder compliance, bladder outlet obstruction, history of stroke, diabetes mellitus (DM) status, and neurological abnormalities were analyzed using chi-square and Mann–Whitney to examine the potential predictors of DU. The odds ratio (OR) of each factor was also calculated. Logistic regression was furtherly used for the analysis.

RESULTS A total of 649 patients were included in this study. Male (OR = 1.74, 95% CI = 1.28–2.38) and DM patients (OR = 2.06, 95% CI = 1.36–3.11) had a higher risk of DU, while bladder outlet obstruction (OR = 0.54, 95% CI = 0.39–0.76) was the protective factor of DU. Furthermore, multivariate analysis showed that the potential predictors of DU were male (OR = 1.903, 95% CI = 1.37–2.64), DM (OR= 1.899, 95% CI = 1.22–2.95), and bladder outlet obstruction (OR = 0.32, 95% CI = 0.32–0.65).

CONCLUSIONS Age, sex, bladder outlet obstruction, and history of DM could become the predictors of DU.

KEYWORDS detrusor underactivity, urinary bladder, urodynamics

According to the International Continence Society, detrusor underactivity (DU) is a urodynamic diagnosis of "a contraction of reduced strength and/or duration, resulting in prolonged bladder emptying and/or failure to achieve complete bladder emptying within a normal time span".[1] DU is a prevailing clinical problem in patients with lower urinary tract symptoms (LUTS). It may cause urinary retention, recurrent urinary tract infections, and renal impairment, resulting in a significant aggravation due to both voiding and storage LUTS.[2] Besides, clinical symptoms related to DU are not clearly defined. Gammie et al[3] concluded patients with DU had a higher occurrence of reduced and/or interrupted stream, hesitancy, incomplete bladder emptying, palpable bladder, and absent and/or decreased sensation during urination.[3]

The epidemiology of DU is uncertain due to the unclear definitions and lack of accurate and easily measurable diagnosing methods. Moreover, the

overlapping clinical symptoms of DU with bladder outlet obstruction and other bladder abnormalities further complicate the circumstances. DU was common in men aged <50 years (9–28%) and increased significantly in men aged >70 years (48%), while DU was varied in women aged >70 years (12–45%).[4] In Indonesia, the prevalence of DU between 2010 and 2015 in an Indonesian national hospital was 17.1%.[5] More than half of patients with LUTS and urinary retention were diagnosed with DU using urodynamic.[6]

Urodynamic utilization in Indonesia is still limited. Only 35% of the urologists worked in a hospital with a urodynamic study.[7] Some urologists argued that the consideration for performing urodynamics was caused by the high cost of urodynamic study.[8] Moreover, urodynamics should be efficiently performed in selected patients to reduce the risk of emerging complications during and after the procedure. Hence, this study was aimed to identify several potential predictors of DU for a limited clinical setting.

METHODS

This retrospective study used data retrieved from the medical records of 649 patients who underwent urodynamics in the Department of Urology, Cipto Mangunkusumo Hospital from 2015 to 2020. Data of age, sex, bladder capacity, bladder compliance, bladder outlet obstruction, history of stroke, diabetes mellitus (DM), and neurological abnormalities were obtained. A urodynamic study was divided into filling and voiding phases. The filling phase consisted of bladder capacity, bladder compliance, detrusor overactivity incontinence, and urodynamic stress incontinence. Meanwhile, the voiding phase investigated DU, atonic bladder, detrusor sphincter dyssynergia, and a combination of bladder outlet obstruction and DU. In this study, patients were diagnosed with DU based on the urodynamic analysis.

Bladder capacity was classified into small (<250 ml), normal (250–500 ml), and large (>500 ml). Bladder compliance is a shift or response in bladder pressure for a given change in volume, which was classified into low and normal.[9] Bladder outlet obstruction was diagnosed with increased detrusor pressure and a low urinary flow condition. In men, intravesical obstruction was identified using the bladder outlet obstruction index formula (Equation 1):

PdetQmax – 2Qmax (1)

Patients were then classified as having obstruction (>40), equivocal (20–40), or no obstruction (<20).[10] Meanwhile, women were diagnosed with bladder outlet obstruction when the maximum flow rate (Qmax) was <12 ml/sec, and detrusor pressure at Qmax (PdetQmax) was >20 cm H_2O. Other comorbidities, such as strokes, DM, and neurological disorders (spine disorders, brain tumors, Parkinson's disease, and neuropathy), were also identified through the medical records.

Chi-square test and odds ratio (OR) were used to analyze DU and other variables such as age, sex, bladder capacity, bladder compliance, bladder outlet obstruction, history of stroke, DM, and neurological abnormalities. Logistic regression was used to obtain the potential predictors of DU. SPSS software version 24.0 (IBM Corp., USA) was used for all statistical analyses.

RESULTS

Of 649 patients undergoing urodynamic study, 337 had DU. Most DU patients were male, older adults, had DM, had bladder outlet obstruction, and had a history of stroke, as shown in Table 1. Thus, the multivariate analysis showed that the potential predictors of DU were male sex, history of DM, and bladder outlet obstruction.

DISCUSSION

We found that 52.0% of subjects undergoing urodynamic study in our center had DU. DM, bladder outlet obstruction, neurological, and undefined age-related abnormalities were the factors associated with DU.[11] In this study, most DU patients were older adults. Yoshida and Yamaguchi[12] found that changes in the structural and functional tissues during aging could contribute to altered bladder afferent activity, resulting in reflex loss of detrusor voiding activity and DU. Male patients were also at higher risk of developing DU. Yu and Jeong[13] showed DU was more common in older men than in women (25–48% *versus* 12–24%).

Benign prostate enlargement may cause bladder outlet obstruction, which oppresses the urethra and eventually increases the urethral resistance and detrusor's micturition effort. As it progresses, an overactive bladder may occur because of an increased detrusor muscle's sensitivity to stimulation. This

Table 1. Analyses of the potential predictors of DU

Factors	Detrusor underactivity, n (%) (N = 649)		Bivariate analysis*		Multivariate analysis†	
	Yes	No	*p*	OR (95% CI)	*p*	OR (95% CI)
Male sex	208 (58.1)	150 (41.9)	**<0.001**	1.74 (1.28–2.38)	**<0.001**	1.90 (1.37–2.64)
Age (years), median (range)	53 (5–89)	50.5 (2–87)	**0.039‡**	-	0.101	0.69 (0.99–1.00)
Stroke	255 (52.0)	235 (48.0)	0.92	1.02 (0.71–1.46)	-	-
DM	80 (66.1)	41 (33.9)	**<0.001**	2.06 (1.36–3.11)	**0.004**	1.90 (1.22–2.95)
Neurology abnormalities§	141 (53.2)	124 (46.8)	0.59	1.09 (0.8–1.5)	-	-
Bladder compliance	113 (50.2)	112 (49.8)	0.53	0.9 (0.65–1.25)	-	-
Bladder outlet obstruction	86 (41.5)	121 (58.5)	**<0.001**	0.54 (0.39–0.76)	**<0.001**	0.32 (0.32–0.65)
Bladder capacity			0.18	-	-	-
Small	176 (50.9)	170 (49.1)				
Normal	151 (54.7)	125 (45.3)				
Large	10 (37.0)	17 (63.0)				

CI=confidence interval; DM=diabetes mellitus; DU=detrusor underactivity; OR=odds ratio
*Chi-square test; †logistic regression; ‡Mann–Whitney test; §spine disorders, brain tumors, Parkinson's disease, and neuropathy

pathogenesis may explain the protective effect of bladder outlet obstruction to DU because bladder obstruction may result in detrusor overactivity.[14] Jeong et al[2] also found a lower prevalence of bladder outlet obstruction among men with DU than those without DU due to multifactorial aspects.

Neurological abnormalities such as medulla spinalis/cerebri tumor history, spinal cord and head injuries, Parkinson's disease, spinal operation, and stroke were not related to DU in this study. Cerebrovascular accident may cause an insufficient postganglionic efferent nerve that is clinically transformed into DU by a disturbing urine perception and outflow.[15] Most patients with spinal cord injury (SCI) in sacral/infrasacral undergo DU or spinal shock detrusor areflexia.[16] After the spinal shock, various bladder dysfunctions can sometimes occur, depending on the injury level. Throughout the sacral SCI, damage can result in diminished detrusor reflex or DU.[16] This result is supported by Kim et al[17] who found no differences in LUTS and detrusor muscle function between unilateral and bilateral hemispheric ischemic stroke patients.

DM may lead to lower urinary dysfunction due to diabetes-induced peripheral neuropathy or "diabetic cystopathy", which features an impaired bladder sensation, increased capacity, reduced contractility, and increased post-void residual. Diabetic cystopathy destabilizes the bladder's nerve supply, leading to a combination of voiding efficiency dysfunction and decreased bladder sensation.[18] DM may also affect the bladder, including axonal degeneration and segmental demyelination, culminating in autonomic neuropathy, and reduced bladder sensation. Bladder ischemia is also frequently found in DM patients and can disrupt nerves, contributing to smooth muscle injury and DU.[19]

It was found that sex, DM, and bladder outlet obstruction were the potential predictors of DU. In limited facility settings, these predictors may help clinicians consider performing urodynamic study in patients with LUTS of diminished and/or delayed stream, hesitancy, inadequate bladder emptying, palpable bladder, and absent and/or decreased sensation during urination. However, a recent study by Wada et al[20] suggested that the utilization of uroflowmetry, which produced a sawtooth pattern, is commonly found in patients with DU. Thus, maximizing the uroflow results and considering the predictors and particular symptoms in patients may be effective in diagnosing DU in limited facility settings. The clinicians may also plan further diagnostic methods and initiate a primary intervention.

The limitation of this study includes the potential confounders occurrence, which raises a high risk of bias. Moreover, the patient characteristics between patients with and without DU were not standardized at the beginning of the study. Therefore, a further cohort study is needed to confirm the preliminary result of this study.

In conclusion, this study demonstrated that assessing patients' age, sex, bladder outlet obstruction, and history of DM could become the potential predictors of DU. Based on the results, we suggest urologists without a urodynamic facility consider diagnosing patients with DU when their clinical symptoms and several predicting factors are convincing.

Conflict of Interest

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

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