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ORIGINAL RESEARCH

The Prevalence of Detrusor Underactivity and its Symptoms Co-relation with Urodynamic Study Findings in Patients with Lower Urinary Tract Symptoms

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Purpose: This study determines the prevalence and clinical presentation of detrusor underactivity (DU) and its urodynamic characteristics in adult patients with lower urinary tract symptoms (LUTS).

Patients and Methods: This retrospective study has reviewed the symptoms and urodynamic study (UDS) findings of 283 patients with LUTS. Chi-square analysis was used to present the prevalence of UDS characteristics in both sexes.

Results: Out of records of 206 patients included in this study, fifty-one (24.76%) patients were diagnosed with DU based on bladder contractility index. Storage lower urinary tract symptoms were the most prevalent characteristic presentation in both sexes as compared to the difficulty in voiding, recurrent urine retention, and urinary incontinence. Bladder outlet, sphincter EMG findings, and degree of DU were significantly correlated with gender.

Conclusion: DU is a prevalent and sophisticated bladder pathology rather than a simple one. It requires more attention from the urologists, and evaluations, including UDS, to differentiate it from other pathologies.

Keywords: detrusor underactivity, prevalence, lower urinary tract symptoms, urodynamic study

Introduction

Although detrusor underactivity (DU) has neither a standard, detailed definition, nor widely accepted diagnostic criteria in clinical practice, it has started to gain more interest in clinical practice and research.[1] The pathogenesis of DU is also under research, and the absence of effective treatments has caused many urologists to consider DU as an incurable, inconvenient concern.[2] DU is also assumed to be a contributing factor in the development of more significant post-void residuals and recurrent urinary tract infections, which constitute a significant health problem, especially in adult population.[3] Therefore, the health problem becomes complicated by antibiotic resistance.

The International Continence Society has defined DU as a contraction of reduced strength and/or duration, resulting in a failure to achieve complete bladder emptying within a normal time span.[4] Recently, this definition was modified by D'Ancona et al[5] as DU is a low detrusor pressure or short detrusor contraction time, usually in combination with a low-urine flow rate, resulting in prolonged bladder

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emptying and/or a failure to achieve complete bladder emptying within a normal time span.

Up till now, there lacks evidence to evaluate the prevalence of DU separately. However, DU is present in 9–28% of men <50 years of age than in 48% men >70 years. In older women, prevalence ranges from 12–45%.[6] In the Korean population, the prevalence of DU in patients older than 65 years was 40.2% and 13.3% in men and women with lower urinary tract symptoms (LUTS), respectively.[7] Another study from Australia has stated that the prevalence of DU in this study was 23%.[8] DU was previously considered as secondary to the aging process,[9] but it affects different patient groups, suggesting a multifactorial etiology including both myogenic and neurogenic etiologies.[9–11]

Recently, DU as a cause of LUTS in both men and women has been increasingly gaining attention. There is a major issue in the differentiation of underactive bladder symptoms and other causes of lower urinary tract symptoms such as detrusor hyperactivity and impaired contractility (DHIC), hypersensitive bladder (HSB), detrusor overactivity (DO), bladder outlet obstruction (BOO)[12] and Dysfunctional Voiding (DV).[13] In this regard, this study aims to determine the prevalence of DU along with its symptomatic and urodynamics (UDS) characteristics of DU in the Jordanian population.

The prevalence of DU is assumed to be higher among the institutionalized elderly, specifically in incontinent nursing home residents. Also, DU has been associated with a low rate of enhancement in both quality of life and individual symptoms following mid-urethral sling procedure in women and prostate surgery in men. On the contrary, the prevalence and clinical implications of DU remain mostly unknown in the elderly population in the elderly population since no standard measurement techniques or quantitative diagnostic criteria have been developed. In particular, appropriate management and diagnosis of this condition become challenging for physicians caring for elderly patients with LUTS.

To date, the prevalence of DU among the community-dwelling elderly population has been reported by several studies[14,15] even though there has been no standard definition of urodynamic DU. These studies have merely considered small populations and did not assess the clinical attributes of DU. Thereby, most of the appropriate information has been inferred from epidemiological studies of urinary retention regarding the clinical characteristics of DU. This study has hypothesized to determine the prevalence and clinical characteristics of DU in an adult population with LUTS; to develop a better understanding and to establish a foundation for additional studies in this domain.

It is, therefore, necessary to be clear on its classification based on the potential etiologic mechanisms induced by different risk factors. However, one possible dilemma is that so far, no universally approved criteria have been ascertained for the classification of LUTS. Interest in DU among urologists has increased recently since it is a common occurrence that elevates with age, and it remains unexplored in clinical practices. Therefore, DU needs a urodynamic assessment for proper diagnosis. Previous studies, as well as reviews, have explained voiding dysfunction in women with an emphasis on its association with dysfunctional voiding attributes.[12,16]

Patients and Methods

Study Design and Patients

The study has reviewed a retrospective chart for 283 patients with LUTS who underwent UDS from July 2016 to August 2019. The study was approved by the Institutional Review Board (IRB). Records of patients 77 were excluded in the initial stage either due to missing data (4 cases) or exclusion criteria (73 cases). Following were the exclusion criteria: patients with neurogenic bladder (NB) due to known underlying neurological disease, history of open pelvic surgery or major abdominal surgery, or using indwelling catheters or clean intermittent catheterization (CIC) due to anatomical deformation of the lower urinary tract, impaired general health that influenced voiding or a neurogenic impairment influencing micturition function.

Therefore, the final study population was considered to be 206 patients. All patients in this study underwent comprehensive history taking, detailed physical examinations, and invasive urodynamic examinations, including filling cystometry, pressure-flow study urethral sphincter Electromyography (EMG) using Perineal patch electrodes. The ICS Good Urodynamic Practice Standards were followed to perform clinical urodynamic practice.[17] The bladder contractility index below 100 was used as an objective parameter to define DU. Furthermore, DU was classified into three categories: mild, moderate, and severe based mainly on detrusor pressure considering the maximum urinary flow rate (Pdet@Qmax) values. A Pdet@Qmax of >40 cmH2O is accepted as normal; 30–40 cmH2O as mild; 20–30 cmH2O as moderate, and <20 cmH2O as severe DU.[9] All patients have signed a formal written consent to perform UDS and to use their anonymous information in clinical research as part of the IUC policy.

Urodynamic Evaluations

All participants have had a thorough symptomatic evaluation for LUTS by completing the Arabic version of the International Prostate Symptom Score (IPSS),[18] as well as the Arabic version of the International Consultation on Incontinence short-form questionnaire (ICIQ-UI SF).[19] All participants had also gone through the urodynamic testing based on ICS standards. The assessment of urodynamic variables was based on: cytometric bladder capacity, presence of detrusor overactivity (DO), detrusor underactivity (DU), bladder volume at first sensation of bladder filling, normal and strong desire for urination, detrusor overactivity and impaired contractility (DOIC), Hypersensitive Bladder (HSB), detrusor pressure at maximum flow (PdetQmax), maximum flow rate (Qmax) volume voided, the post-void residual urine volume (PVR), and sphincter EMG characteristics.

Secondary urodynamic voiding parameters of Bladder Contractility Index (BCI) (PdetQmax + 5Qmax) and Bladder Outlet Obstruction Index (BOOI) (PdetQmax – 2Qmax) were calculated and included in the study. DU defined as a bladder contractility index of less than 100, for which the index was computed from the findings of the pressure-flow study (PFS).[5,20]

Statistical Analysis

Data were entered into Microsoft Office Excel. The IBM SPSS version 21.0 (IBM Co., New York, NY, USA) was used to present frequency tables through mean and standard deviation (SD). Median and proportions were used to present non-normally distributed variables and categorical variables, respectively. Chi-square analysis was used to determine the relationship between urodynamic characteristics and DU prevalence. A 2-tailed p-value <0.05 was used to determine the statistical significance.

Results

Out of 206 patients, 51 patients (26 males and 26 females) had bladder contractility index below 100 and were labeled as DU, yielding a prevalence rate of 24.76%. Only patients with DU proceeded for further analysis while the rest of the patients were dropped from the study and diagnosed as healthy. The reason behind dropping-off those healthy patients was that the pressure characteristics are difficult to standardize, and, therefore, focusing only on DU patients and associated symptoms would help the researcher to define a predictable pattern. Table 1 shows the clinicodemographic characteristics of patients. The findings indicate that patients were more prevalent in reporting storage symptoms as compared to other indications for UDS, such as urinary incontinence (UI), recurrent urine retention (RUR), and voiding symptoms. The most prevalent symptom reported according to the IPSS questionnair was day time-frequency (74.5%).

Table 1 Clinical-Demographic Characteristics

		Frequency	Percent
Gender	Female	25	49.0
	Male	26	51.0
Age (years)	Mean± standard deviation (48.74 ±20.27)		
Marital status	Married	31	60.8
	Single	15	29.4
	Widow	5	9.8
Chief complaint	Decrease bladder sensation	1	2.0
	Difficulty of voiding	6	11.8
	High residual	1	2.0
	LUTS	20	39.2
	Nocturnal enuresis	3	5.9
	Pain	4	7.8
	Post void dribbling	1	2.0
	Recurrent urine retention	6	11.8
	Urinary incontinence	7	13.7
	Urgency	2	4.0
Type of presenting symptom	Pain	4	7.8
	Storage	23	45.1
	Urinary incontinence	11	21.6
	Voiding	13	25.5
Reason for referral	LUTS evaluation	19	37.3
	Failed medical treatment	28	54.9
	TVT evaluation	4	7.8

However, the prevalence of incomplete emptying, intermittency, straining, weak stream, nocturia, and urgency was 45.1%, 60.8%, 66.6%, 68.6%, 70.5%, and 72.5% respectively (Figure 1). All patients reported a significant impact on the quality of life due to urinary symptoms, as their responses to the 8th question of the IPSS questionnaire were mixed(3.9%), unhappy(41.2%), mostly dissatisfied(31.4%), and terrible(23.5%) .

Tables 2 and 3 present the UDS findings associated with DU, and revealed that the mean PdetQmax was (29.71 cmH2O), and the mean Qmax was (8.1 mL/sec) with a mean BCI of (68.01). Furthermore, bladder contractility was found to be weak in both sexes (84.3%). Dysfunctional voiding was prevalent in 34 patients (66.7%) as compared to normal urethral function.

The association between UDS findings and gender are shown in Table 4. The findings indicated an insignificant association of bladder sensitivity, detrusor function during filling cytometry, bladder contractility, and PSHx by gender ($p > 0.005$). However, bladder outlet, sphincter EMG, and degree of DU were significantly correlated with both sexes. Females showed a greater degree of DU ($p = 0.007$) and a greater association with dysfunctional voiding ($p = 0.010$) on EMG. On the contrary, males showed more bladder outlet obstruction as compared to females ($p = 0.006$). Table 5 shows the association of urodynamic characteristics to diagnosis. The relationship between diagnosis and urodynamic characteristics was statistically significant based on bladder sensitivity, degree of DU, and gender.

Discussion

The bladder contractility becomes impaired with age, resulting in a high prevalence of DU in both males and females. DU has received a little scientific attention even though it was assumed to be a common geriatric condition because the urodynamic characteristics have not been demonstrated and lack a gold standard diagnostic criterion. The actual prevalence of DU among the community-dwelling individuals remains unidentified. Therefore, this study has aimed to determine the prevalence and clinical presentation of DU and its urodynamic characteristics in both sexes in adult patients. To the best of the researcher's knowledge such kind of study has not been conducted in the Jordanian population before.

This study has focused on patients with LUTS who were over 18 years of age and were capable of performing regular tasks by themselves. Patients were assumed to influence micturition function, having neurogenic abnormalities, or regularly utilized a catheter for urine drainage were excluded from the study population. It was believed that emphasizing this population elevated the clinical similarity of this study cohort with community-dwelling elderly as compared to the elderly in chronic care facilities.

The findings indicated that the prevalence of DU was similar to DO in men and increased with age in both males and females. The study has not reached a conclusive demonstration of the higher occurrence of DU in adult men as compared to adult women. On the contrary, it was assumed that the higher prevalence of DU in adult

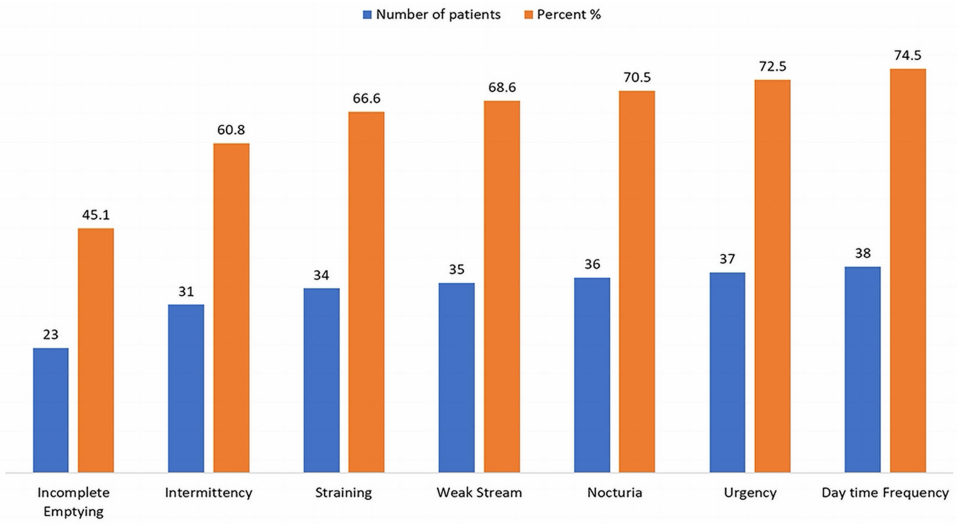

Figure 1 Prevalence of urinary symptoms among patients with DU according to their responses to the IPSS questionnaire.

Table 2 UDS Parameters

UDS Parameters	Minimum	Maximum	Mean	Std. Deviation
1st sensation (mL)	20	472	136.18	106.694
Normal desire (mL)	32	800	214.87	154.701
Strong desire (mL)	70	880	287.70	182.232
MCC (mL)	75	890	345.35	195.749
Detrusor pressure at maximum flow (cmH2O)	2	67	29.71	16.299
Maximum flow rate (Qmax) mL/sec	0	36	8.10	5.792
BCI	2	96	68.01	24.350
Volume voided (mL)	0	550	185.78	125.853
Postvoid residual (PVR) urine volume (mL)	0	840	163.94	206.454
BOOI	−60	63	13.52	22.079
IPSS score	0	34	12.96	7.008

men is likely to be multifactorial as compared to adult women. The prevalence of DU was 24.76%, and this was similar to previous studies.[18,19] These outcomes have indicated that DU is considered as an essential element of the pathophysiology of LUTS in the adult population, as the patients get older. The prevalence of BOO might be partly classified to the exclusion of men with LUTS across the age spectrum indicative of BPH who received medication regardless of a urodynamic evaluation.[21]

Table 3 UDS Findings Associated with DU

		Frequency	Percent
Bladder contractility	A-contractile	8	15.7
	Weak	43	84.3
Sphincter EMG	DSD	1	2.0
	Dysfunctional voiding	34	66.7
	Normal urethral function	16	31.4
Bladder outlet	Equivocal	15	29.4
	Obstructed	7	13.7
	Unobstructed	29	56.9
Bladder sensitivity	Hypersensitive	23	45.1
	Hyposensitive	13	25.5
	Normal	15	29.4
Detrusor function during filling cystometry	Detrusor overactivity (DO)	20	39.2
	Normal	31	60.8
Compliance	Low	9	17.6
	Normal	42	82.4

The findings have also indicated that both sexes with DU were also prevalent to DO, HSB, and BOO. A previous study has also reported similar findings.[15] This finding is a significant demonstration in the adult population for the clinical management of LUTS. The voiding difficulty might be aggravated by using antimuscarinics for the treatment of DO, resulting in chronic or acute urinary retention in patients with DU and DO respectively.[22] Medical treatment has been given to the majority of the patients, which might be reflected with missed diagnosis due to the long duration of the prevalent problem and overlap of DU characteristics with other common symptoms such as bladder overactivity, urinary tract infections, and BOO.[23,24] The findings of the current study are supported by the findings of Rademakers et al,[25] who reported a prevalent increase of hesitancy, weak stream, and incomplete bladder emptying in women with DU as compared to men.

Cut-off values were used for the diagnosis of BOO or DU based on the PFS in women. However, the diagnosis of BOO or DU in women reflects barrier owing to the lack of predefined criteria compared to their diagnosis in men. The PFS cut-off values were adopted in this study for the diagnosis of DU in women. This series of criteria reflects on being stricter for the diagnosis of female DU as compared to the criteria utilized in previous studies. The population of this study includes both cohorts of intrinsic bladder dysfunction and bladder outlet obstruction. The value of UDS in differentiating bladder outlet dysfunction had been well-attributed in previous studies. However, this analysis has emphasized the sub-group of the intrinsic dysfunction, particularly for those with DU, and this approach was completely different from the previous work.

Table 4 Chi-Square Analysis Between Urodynamic Characteristics and Gender

		Gender		
		Male	**Female**	**P-value**
Bladder sensitivity	Hypersensitive	9	14	0.217
		34.6%	56.0%	
	Hyposensitive	9	4	
		34.6%	16.0%	
	Normal	8	7	
		30.8%	28.0%	
Detrusor function during filling cytometry	Detrusor overactivity	8	12	0.165
		30.8%	48.0%	
	Normal	18	13	
		69.2%	52.0%	
Degree of DU	Severe	6	8	0.007
		23.1%	32.0%	
	Moderate	3	6	
		11.5%	24.0%	
	Mild	5	10	
		19.2%	40.0%	
Bladder contractility	A-Contractile	5	3	0.374
		19.2%	12.0%	
	Weak	21	22	
		80.8%	88.0%	
Sphincter EMG	DSD	0	1	0.010
		0.0%	4.0%	
	Dysfunctional voiding	13	21	
		50.0%	84.0%	
	Normal urethral function	13	3	
		50.0%	12.0%	
Bladder outlet	Equivocal	9	6	0.006
		34.6%	24.0%	
	Obstructed	7	0	
		26.9%	0.0%	
	Unobstructed	10	19	
		38.5%	76.0%	
PSHx	Abdominal Sx, genealogical	0	1	0.163
		0.0%	4.3%	
	Abdominal Sx, other	0	1	
		0.0%	4.3%	
	Gynalogical	0	3	
		0.0%	13.0%	
	Urological	3	3	
		11.5%	13.0%	
	Other	23	15	
		88.5%	65.2%	

(*Continued*)

Table 4 (Continued).

Strength and Limitations

Several limitations were found in this study. Firstly, the sample size prevalent in the bladder contractility index was small (n = 51). This limitation is may be due to the findings that were derived from a single tertiary center. In this regard, a multi-center prospective study will be required for confirming the findings. Secondly, patients were excluded from the study population who did not undergo a urodynamic assessment due to the retrospective design of the study. Lastly, the study has not included a control group of healthy cases for further comparison, which should be considered in future studies with more cases.

Conclusion

DU is a prevalent and sophisticated bladder pathology rather than a simple one. It requires more attention from the urologists, and comprehensive evaluations, including UDS, to differentiate it from other pathologies. Physicians who manage adult patients should understand the age-related pathophysiological changes, considering the findings of this study on the prevalence and clinical features of DU. Additional studies should make use of longitudinal trials as compared to cross-sectional trials for determining the natural history of DU in the adult population.

Clinical Trial Registration Number

NCT04336280.

Table 5 Chi-Square Analysis Between Urodynamic Characteristics and Diagnosis

		Diagnosis			
		DOIC	**DU**	**HSB**	**P-value**
Gender	Male	3	21	2	0.042
		50.0%	61.8%	18.2%	
	Female	3	13	9	
		50.0%	38.2%	81.8%	
Bladder sensitivity	Hypersensitive	0	12	11	0.001
		0.0%	35.3%	100.0%	
	Hyposensitive	3	10	0	
		50.0%	29.4%	0.0%	
	Normal	3	12	0	
		50.0%	35.3%	0.0%	
Degree of DU	Severe	1	12	1	0.023
		16.7%	35.3%	9.1%	
	Moderate	3	4	2	
		50.0%	11.8%	18.2%	
	Mild	0	8	7	
		0.0%	23.5%	63.6%	
Bladder contractility	A-contractile	0	8	0	0.093
		0.0%	23.5%	0.0%	
	Weak	6	26	11	
		100.0%	76.5%	100.0%	
Sphincter EMG	DSD	0	0	1	0.171
		0.0%	0.0%	9.1%	
	Dysfunctional voiding	4	21	9	
		66.7%	61.8%	81.8%	
	Normal urethral function	2	13	1	
		33.3%	38.2%	9.1%	
Bladder outlet	Equivocal	2	10	3	0.362
		33.3%	29.4%	27.3%	
	Obstructed	2	5	0	
		33.3%	14.7%	0.0%	
	Unobstructed	2	19	8	
		33.3%	55.9%	72.7%	
PSHx	Abdominal Sx, gynalogical	0	0	1	0.273
		0.0%	0.0%	10.0%	
	Abdominal Sx, other	0	0	1	
		0.0%	0.0%	10.0%	
	Gynalogical	1	2	0	
		16.7%	6.1%	0.0%	
	Urological	1	4	1	
		16.7%	12.1%	10.0%	
	Other	4	27	7	
		66.7%	81.8%	70.0%	
Pain	Yes	1	10	5	0.432
		16.7%	29.4%	45.5%	
	No	5	24	6	
		83.3%	70.6%	54.5%	

Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Consideration

The study was approved by the Institutional Review Board (IRB) at the Istishari Hospital/Amman/Jordan, and it was performed in accordance with the Declaration of Helsinki.

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Disclosure

The authors report no conflicts of interest for this work.

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