ORIGINAL ARTICLE

Eastern Journal of Medicine
East J Med 26(1): 139-144, 2021
DOI: 10.5505/ejm.2021.92678

The Types of Urodynamic Detrusor Overactivity and its Relationship With Neurological Diseases. 10-years Follow-up of 1000 Invasive Urodynamic Studies

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ABSTRACT

The aim of this study is to compare detrusor overactivity (DO) subtypes namely terminal (TDO) and phasic (PDO) in terms of frequency, etiologic reasons, urodynamic findings and relationships with neurological diseases.

Patients' characteristics including age, gender, neurological diseases, were noted. Bladder volume on the first desire to voiding (FSD), the strong desire to voiding (SDV), maximum bladder capacity (MBC), bladder compliance (BC), presence and type of DO, and amplitude of DO (Ad) were also noted during the IUDS. Patients with TDO and PDO were compared in terms of patient characteristics, urodynamic parameters, and neurological diseases.

1018 patients were enrolled in the study. Neurological disease was noted in 180 patients; spinal cord trauma (SCT):46, Alzheimer Disease (AD):8, Parkinson's Disease (PD):12, spina bifida (SB):21, epilepsy (ED):18, cerebrovascular disease (CVD):20 and Multiple Sclerosis (MS):55. Urodynamic DO was observed in 882 patients (neurogenic-DO:149 and idiopathic-DO:733), (PDO:837, TDO:45). A significant difference was observed between the groups regarding the FSD, MBC and Ad (p=0.032, p=0.049 and p=0.001 respectively). However, no difference was observed in BC (p=0.510). The incidence of TDO and PDO was 6% and 5% for neurogenic-DO and 94% and 95% for the idiopathic-DO, respectively (p=0.327). Among the neurogenic diseases only patients with SCT had significant differences regarding type of DO (TDO 11.1%, PDO 3.1%) (p= 0.04).

Neurogenic diseases are not a significant risk factor for TDO. Spinal cord trauma is associated with higher rates of TDO compared to other neurogenic diseases.

Key Words: Detrusor overactivity, urodynamic, urinary bladder, neurogenic, terminology

Introduction

Invasive urodynamic studies (IUDS) are frequently used methods for the evaluation, diagnosis, and follow-up of lower urinary tract symptoms (LUTS). The terminology of urodynamics was standardized by the International Continence Society (ICS) in 2002 (1) and was lastly updated in 2019 (2). In this update, urodynamic detrusor overactivity (DO) is defined as the observation of spontaneous or provocative urgency symptoms and detrusor contractions at varying durations and amplitudes with or without urinary incontinence during filling cystometry.

Some sub-types of DO were also reported. The term idiopathic (primary) detrusor overactivity (IDO) stands for detrusor overactivity without an underlying cause. Neurogenic (secondary) detrusor overactivity (NDO) is defined as DO with an underlying neurological cause. Finally, if DO is based on non-neurogenic etiologies such as stone, obstruction, tumor, etc., it is classified as non-neurogenic (secondary) detrusor overactivity (NNDO) (2).

Furthermore, DO is classified as phasic and terminal according to the time it is observed and its suppressibility during filling cystometry, and the urodynamic trace features (3). Phasic detrusor overactivity (PDO) is defined as involuntary detrusor contraction during filling cystometry with or without urinary incontinence (Figure 1). The term, terminal detrusor overactivity (TDO), is defined as a single involuntary detrusor contraction that cannot be suppressed and that occurs when the maximum bladder capacity is reached, resulting in urinary incontinence and often complete bladder emptying (Figure 2) (1).

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Received: 11.10.2020, **Accepted:** 10.12.2020

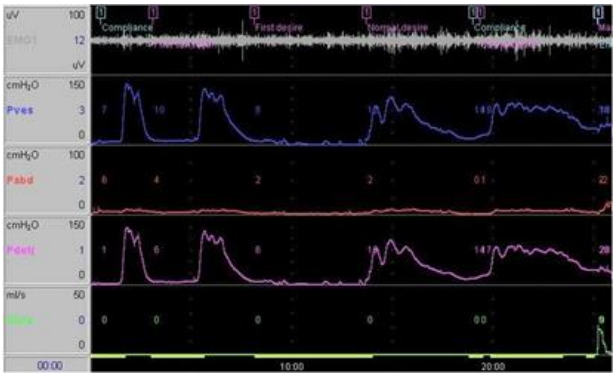

Fig. 1. Phasic detrusor overactivity
Black arrows indicate phasic detrusor contractions during filling phase

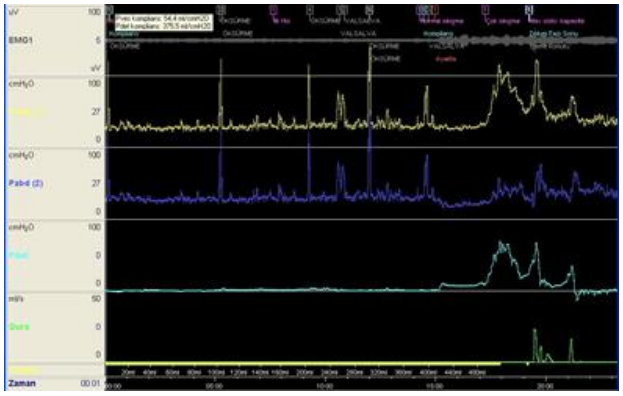

Fig. 2. Terminal detrusor overactivity
The black arrow indicates terminal detrusor overactivity, at the end of filling phase before permission of voiding

Although the ICS divides DO into terminal and phasic subgroups, there are only a few studies about TDO in the current literature (4-6). These studies mainly focused on urodynamic characteristics of TDO rather than clinical effects. Gazewski et al. concluded that decreased bladder sensation in elderly patients with neurogenic problems may be the reason for TDO (3).

There is not enough information regarding the actual frequency and underlying causes of TDO in the literature. Also, the relationship between TDO and neurological diseases is still unknown. In this study, we aim to examine the frequency and the etiological reasons for TDO and its relationship with neurological diseases by comparing it with PDO.

Material and method

Data of 1018 patients who underwent IUDS for LUTS between January 2010 and December 2018 were re-evaluated by three well-trained urologists separately. In case of discrepancy in IUDS reports among the urologists, a re-evaluation was also performed by the urologists together.

The indications for urodynamic evaluation were determined as the routine control of patients with neurological diseases accompanying lower urinary tract symptoms, urinary retention, clinically inexplicable LUTS, and neurological lower urinary system disorders which did not benefit from medical treatment.

Patients with symptomatic and/or > grade 2 pelvic organ prolapse (POP) according to the Baden–Walker classification, with post-prostatectomy incontinence, patients undergoing urodynamics after unsuccessful incontinence surgeries, and patients aged <18 and > 75 years were excluded from the study. Patients with pathologies (bladder stone, bladder tumor, functional bladder outlet obstruction) that may cause non-neurogenic secondary DOA were also excluded from the study.

Patients' characteristics including age, gender, neurological diseases (Multiple sclerosis (MS), spinal cord trauma [SCT], spina bifida [SB], cerebrovascular disease [CVD], Parkinson's disease [PD], Alzheimer disease [AD], epilepsy disease [ED]), history of major pelvic surgery and use of clean intermittent catheterization (CIC) were noted.

IUDS Procedure: The IUDS study was conducted in accordance with the guidelines for urodynamic studies defined by the ICS (7). All patients underwent non-invasive urodynamic studies as uroflowmetry (UF) and post-voided residual urine (PVR) before IUDS. All urodynamic examinations were performed with the Libra + (MMS, Enschede, The Netherlands) air conducted urodynamic system. After the rectal enema, 3-gram fosfomycin was given orally for prophylaxis before the procedure. A 6-french double-lumen disposable urethral catheter was placed in the bladder; the bladder was filled with a saline infusion with a 10ml/second flow rate.

The filling phase continued with an appropriate filling speed until the patient described severe voiding desire, maximum volume detected in clean intermittent catheterization (CIC) or the maximum bladder capacity of the voiding diary was achieved.

Afterward, the pressure-flow study was applied. In patients who could not urinate with the catheters inside the urethra, the catheters were removed. The study was terminated with residual urine measurement after the voiding phase.

Bladder volume on the first desire to voiding, the strong desire to voiding, maximum bladder capacity, compliance, presence and type of DO, and amplitude of DO were noted during the IUDS.

DO accompany by a neurological disease was classified as neurogenic DOA. All other patients were classified as idiopathic DOA. Involuntary detrusor

Table 1. Comparison of the phasic and terminal detrusor overacrivity groups according to baseline and urodynamic parameters

	Phasic Detrusor Overactivity	Terminal Detrusor Overactivity	p
Gender male/female	252/585	17/28	0.276
Age , mean±sd	49.9 ± 15.6	62.4 ± 7.9	0.039
First desire to void,ml, mean±sd	201.4 ±107.1	128.8±45.6	0.032
Strong desire to void, ml,mean±sd	328.5±104	233.0±40.3	0.024
Maximum bladder capacity,ml,mean±sd	463.0 ±105.1	385.1±45.3	0.049
Compliance, mean±sd	54.8±72.8	59.1±61.8	0.501
Bladder volume at first DO*, ml, mean±sd	168.8±97.9	301.9±51.4	0.019
Amplitude of DO, cmH2O, mean±sd	16.3±15.7	52.6±67.1	0.001

*First contraction was considered for PDO

contractions with or without urinary incontinence (with or without accompanying symptom) that could not be suppressed during filling cystometry were accepted as PDO. Involuntary detrusor contractions that could not be suppressed at maximum cystometric capacity and that caused complete emptying of the bladder were accepted as TDO.

Patients with TDO and PDO were compared in terms of demographic data, urodynamic parameters, and neurological diseases. Additionally, the distribution of patients with TDO according to neurological diseases was also examined.

Statistical Analysis: Statistical analysis was performed using SPSS version 20. The distribution of the variables was measured by visual (histogram) and analytical methods (Kolmogorov-Smirrow / Shapiro-Wilks).

Student's test was used for normally distributed variables, and the Mann-Whitney U test was used for not normally distributed variables. The Chi-square test and the Fisher exact test was used to compare categorical variables. A P-value less than 0.05 was considered as statistically significant.

Results

Totally 619 men and 409 women were enrolled in the study. Re-evaluation of the urodynamic study was needed for 158 (17.2%) patients. One hundred eighty of these patients were diagnosed with a neurological disease (SCT: 46, AD: 8, PD: 12, SB: 21, ED: 18, CVD: 20, MS: 55). The 920 of the patients who did not perform CIC reported an average of 10.4 ± 2.3 voids per day and an average of 350 ml (200-800 ml) voided total urine on the voiding diary. Patients who performed CIC were doing it 6 times in a day and all of them were receiving medical treatment.

The mean bladder volume for the first desire to void was 180 ml (50-700 ml), strong desire to void was 270 ml (150-900 ml) and the mean maximum bladder capacity was 380 ml (200-900 ml). The average compliance value was measured as 45 ml/cm H2O (5-800 ml). One hundred sixty-six patients were unable to void during the voiding phase, 25 of these patients were able to achieve spontaneous micturition after removing the catheter, and the remaining 852 patients had a mean PMRI of 130 ml (0-250 ml).

Urodynamic DO was observed in 882 (86.6%) patients. While 149 of those patients were reported as NDO, 733 of them were reported as IDO. Phasic DO was observed in 837 (94.9%) of the patients with urodynamic DO, while TDO was observed in 45 (5.1%).

There was no difference in terms of gender between TDO and PDO groups (p=0.276). However, the mean age of the TDO group was significantly higher than the PDO group (P=0.039). The comparison of patients with TDO and PDO is presented in Table 1. A significant difference was also observed between the groups regarding the volume of the first desire to void, maximum bladder capacity and detrusor contraction amplitude (p=0.032, p=0.049 and p=0.001, respectively). However, no difference was observed in compliance values (p= 0.701).

Of the 149 patients (16.8%) diagnosed with NDO, 31 had a history of spinal cord trauma, 8 had Alzheimer's Disease, 12 had Parkinson's Disease, 11 had Spina Bifida, 15 had Epilepsy Disease, 17 had a cerebrovascular disease and 55 had Multiple Sclerosis.

Table 2. Distributions of detrusor overactivity types

	PDO (n:837)	TDO (n:45)	P Value
Neurogenic DO 149	139 (94%)	10(6%)	0.327
Idiopathic DO 733	698(95%)	35(5%)	

Table 3. Distributions of neurogenic diseases according to detrusor overactivity type

Neurogenic disease	PDO (n:837)	TDO (n:45)	p
Spinal cord injury	26 (3.1%)	5 (11.1%)	0.017
Alzheimer's Disease	8 (0.9%)	0 (0%)	1
Parkinson's Disease	11(1.3%)	1 (2.2%)	0.468
Spina bifida	11(1.3%)	0 (0%)	1
Epilepsy	15(1.7%)	0 (0%)	1
Cerebrovascular disease	16(1.9%)	1 (2.2%)	0.592
Multiple sclerosis	52(6.2%)	3 (6.6%)	0.755

The incidence of TDO and PDO was calculated as 6% and 5% for the NDO and 94% and 95% for the IDO groups, respectively. No statistically significant difference was found between the groups (p= 0.327) (Table 2).

The distribution of patients with NDO according to neurogenic diseases and the type of DO is summarized in table 3. The comparison of the rates of TDO and PDO in patients with neurological diseases separately revealed significant differences only in the SCT group (TDO)

Discussion

There is an absolute heterogeneity regarding the rates of DO in urodynamic studies in the literature. Hashim et al. explained the discordance in DO rates among the studies with differences of the study populations, to the difference in the threshold for the detrusor contraction amplitude and the duration of detrusor contraction, and the presence of significant symptoms (8). Digesu et al. reported DO as 36.5% in their urodynamic series of 4500 patients (9). However, they considered detrusor contractions during urgency as significant for DO. On the other hand, Baumeister et al. determined DO as 66% in their series of 1598 patients and emphasized that if they continued the urodynamic study after 500 ml of bladder volume, this rate increased by 16% (10). In our study the frequency of DO was defined as 86%, which is quite high compared to the literature. Considering all detrusor contractions as significant even in the absence of symptoms, our tendency to continue the urodynamic procedure until volumes over the functional bladder capacity are reached, and the widely use of urodynamics at the beginning, especially in patients who were follow-up during their overactive bladder syndrome treatment, can be considered as the reasons for the high rate.

Kessler et al. reported that terminal overactivity is more common in the elderly (11). On the other hand, Tong et al reported that TDO is more common in patients with benign prostatic enlargement with decreased bladder sensation in elderly male patients but without complaints of urgency (6). In another study on female patients with overactive bladder Valentini et al. reported the incidence of TDO between the ages of 18 and 44 as 6.7 %, while it was 23.2% for women over 75 years old (4). Furthermore, Valentine et al. stated that PDO was observed more frequently in young patients, and also observed no difference in the frequency of TDO and PDO between females and males (5). According to our study, there is no difference in patients with and without DO in terms of age and gender. However, the average age of the group with TDO was higher than the PDO group. This can be explained by the decreases in contractility capacity and bladder capacity also increase in bladder sensation and defect in the coordination of the external sphincter in the aging bladder (11).

It is known that the higher incidence of DO was reported in urodynamic studies in patients with neurological diseases (12, 13). However, the relation between the types of DO and neurological diseases has been evaluated only in a few studies. Francoise et al. reported that the incidence of TDO increased intracranial neurological diseases especially in elderly patients (4). Another study published by Gliga et al. reported that the incidence of PDO increased in patients diagnosed with spinal cord trauma and MS (14). Our study revealed no difference between patients with and without neurological disease in terms of DOA. Additionally, there was no difference

between the two groups regarding the frequency for TDO and PDO. The fact that the majority of neurological diseases include patients with MS and spinal cord trauma may explain this result.

Studies comparing DO types according to urodynamic findings mostly use data of NDO and IDO. Lemack et al. reported higher volumes (186 ml vs 150 ml), higher amplitude (46 cmH2O vs 30 cmH2O) detrusor contractions and higher post voided residual urine volumes (PVR) values in patients with NDO compared to IDO (15). Golabeck et al. reported similar results in diabetic patients (16). However, Valentine et al. did not determine any difference in the urodynamic results of patients with NDO and IDO in terms of volume, detrusor contraction amplitude or maximum bladder capacity in their series; they attributed this finding to the fact that they investigated TDO and PDO separately (5).

Bladder volume at first DO is observed was the only statistically significant difference between the groups. This value was lower in patients with idiopathic PDO than in cranial neurogenic TDO and was lower in patients with spinal cord originated neurogenic TDO than in patients with idiopathic PDO (5). In our study, only TDO and PDO were compared. While lower bladder capacity was observed in patients with TDO, lower maximum bladder volume, and higher detrusor contraction amplitudes were observed in the PDO group.

Nelson et al. explained the pathophysiology of TDO with the inappropriate compensation of decreased bladder capacity and increased detrusor contraction amplitude by external urethral sphincter due to impaired neurological function (17). Studies including the urethral pressure profile measurements will be more informative on this subject

There is only one study in the literature comparing the type of DO observed in different neurological diseases (5). However, in this study, the authors studied TDO and PDO frequencies according to the localization of lesion in the spinal cord. NDO was reported in 91 of 203 patients with DO (PDO: 41, TDO: 50) and intracranial neurological disorders caused most frequently to TDO. Our study revealed a higher incidence of TDO in patients with spinal cord trauma. We think that it may be wrong to make a certain conclusion in terms of the comparison of DO types according to diseases since there is limited information about TDO in literature.

Limitation: The primary limitation of the study is the retrospective nature of the study as well as the absence of video urodynamics findings and the low number of patients with TDO. The absence of data for follow-up and treatment outcomes of the patients diagnosed with TDO should be stated as another limitation.

Neurogenic diseases are not a significant risk factor for TDO. Spinal cord trauma differs from other neurogenic disorders causing LUTS in terms of the incidence of TDO. Studies that demonstrate the long-term follow-up of patients are needed to reveal the clinical importance of TDO.

Acknowledgement: None

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