



# The Results of Urodynamics and Pressure Flow Study of Patients with Neurological Disease in a Single Center for 12 Years: Neurogenic Bladder Etiology

Tek Merkez, Nörolojik Hastalığı Olan Hastaların 12 Yıllık Ürodinami ve Basınç Akım Çalışması Sonuçları: Nörojenik Mesane Etiyolojisi

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## ABSTRACT

**Aim:** Generally, urodynamic-pressure flow study (U-PFS) is performed on patients with lower urinary tract symptoms (LUTS) for verifying the diagnosis and evaluating the rate of response for treatment. The aim of the study was to assess the results of the U-PFS of patients according to the etiology of neurological disorders.

**Materials and Methods:** The data of 2,489 patients who underwent U-PFS in our clinic between 2010-2022 were analyzed retrospectively. A total of 535 patients with LUTS and neurogenic disorder were included in the study. Patients were divided into subgroups according to their diagnosis. The patient's age, gender, and U-PFS data (sensation of first urine, maximum cystometric capacity (MSC), maximum detrusor pressures in the filling phase, presence of urgency, and bladder compliance status) were evaluated and compared according to neurological disorders.

**Results:** Cervical and lumbar disc disorder was found in 204 (38.1%) patients, multiple sclerosis (MS) in 103 (19.2%), and cerebrovascular incidents in 74 (13.8%) patients (SVI), spinal cord injury in 48 (8.9%), polyneuropathy in 43 (8.0%), Parkinson's disease (PD) in 30 (5.6%), diabetic neuropathy in 18 (3.4%), and operated spine bifida (oSB) in 15 (2.8%) was detected. Detrusor pressures in the filling phase were compared according to neurological disorders, and detrusor pressures were statistically significantly higher in patients with oSB and PD (52.66±40.78 mmHg; 45.30±34.43 mmHg, respectively;  $p<0.001$ ). When the MSCs were compared, it was observed that the bladder capacity was significantly lower in PD and ASD patients, whereas bladder capacity was relatively increased in lumbar and servical disc disorder, spinal cord injury and polyneuropathy patients (respectively 308.71±190.25 mL, 264.81±140.25 mL, 491.90±167.49, 474.52±182.92, 447.67±168.03,  $p<0.001$ ).

**Conclusion:** These specific patient groups (oSB and spinal cord injury) are hazardous groups for the development of end-stage kidney failure. Clinicians should take into consideration that patients and their relatives have to be informed about possible long-term complications.

**Keywords:** Neurogenic bladder, urodynamic study, epidemiology

## ÖZ

**Amaç:** Çalışmamızda, kliniğimize alt üriner sistem semptomları (AÜSS) ile başvuran ve nörolojik hastalığı olan hastaların ürodinami-basınç akım çalışması (Ü-BAÇ) sonuçlarının belirlenmesi ve bu bulguların nörolojik hastalıkların etiyojisine göre karşılaştırılması amaçlanmıştır.

**Gereç ve Yöntem:** Kliniğimizde 2010-2022 yılları arasında Ü-BAÇ yapılan 2.489 hastanın verileri retrospektif olarak incelendi. AÜSS ve nörojenik hastalığı olan toplam 535 hastanın verileri çalışmaya dahil edildi. Hastalar tanılarına göre alt gruplara ayrıldı. Hastaların yaş, cinsiyet, Ü-BAÇ verileri [ilk idrar hissi, maksimum sistometrik kapasitesi (MSK), dolum fazında maksimum detrüör basınçları, ani sıkışma hissi varlığı ve mesane kompliyansı] değerlendirilmeye alınarak mevcut nörolojik hastalıklara göre karşılaştırıldı.

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**Bulgular:** Kliniğimizde nörolojik hastalığı olan ve Ü-BAÇ yapılan hastaların 204'ünde (%38,1) servikal ve lomber disk bozukluğu, 103'ünde (%19,2) multipl skleroz (MS), 74'ünde (%13,8) serebrovasküler olay, 48'inde (%8,9) spinal kord yaralanması, 43'ünde (%8,0) polinöropati, 30'unda (%5,6) Parkinson hastalığı (PH), 18'inde (%3,4) diyabetik nöropati ve 15'inde (%2,8) opere spina bifida (oSB) olduğu tespit edildi. Dolum fazındaki detrüsor basınçları karşılaştırıldığında oSB ve MS hastalarında detrüsor basınçları istatistiksel olarak belirgin yüksek olduğu saptandı (sırasıyla  $52,66 \pm 40,78$  mmHg;  $45,30 \pm 34,43$  mmHg;  $p < 0,001$ ). MSK'lar karşılaştırıldığında, PH ve oSB hastalarında mesane kapasitesinin belirgin düşük, lomber disk bozuklukları, opere lomber, servikal fraktür ve polinöropati hastalarında ise mesane kapasitesinin görece artmış olduğu gözlemlendi (sırasıyla  $308,71 \pm 190,25$  mL,  $264,81 \pm 140,25$  mL,  $491,90 \pm 167,49$ ,  $474,52 \pm 182,92$ ,  $447,67 \pm 168,03$ ,  $p < 0,001$ ).

**Sonuç:** oSB ve spinal kord yaralanması olan hastaların ürodinamik verileri değerlendirildiğinde, bu hasta gruplarının son dönem böbrek yetmezliği açısından üst üriner sistemin etkilenmesi açısından çok yüksek risk altında olduğu görülmektedir. Klinisyenler özellikle bu iki nörojenik hastalık grubunda takip protokolünü oluştururken bunları göz önüne almalı ve olası gelişebilecek yakın ve uzun dönem komplikasyonları hastalarla paylaşmalıdır.

**Anahtar Kelimeler:** Nörojen mesane, ürodinamik çalışma, epidemiyoloji

## INTRODUCTION

Lower urinary tract symptoms (LUTS) due to neurological diseases may vary depending on the neurological disease or the localization of the neurological disease. For example, neurogenic detrusor overactivity is expected in neurological diseases with suprapontine involvement, while underactive detrusor or acontractile detrusor come to the fore in diseases with peripheral nervous system involvement. Even patients with the same neurological disease may apply to the clinic with different LUTS.

In some neurological diseases, LUTS may appear before the development of neurological findings, and patients may be diagnosed with neurological disease after the occurrence of LUTS. Especially 10% of multiple sclerosis (MS) patients can apply to a physician with only LUTS<sup>1</sup>. Therefore, the possibility of neurological disease in patients with LUTS or LUTS in patients with neurological disease should be questioned. In the evaluation of LUTS in patients with neurological disease, urodynamic testing, which is an invasive test, and, if necessary, a pressure flow study is recommended<sup>2</sup>.

Although there are many studies in the literature on LUTS in neurological diseases, there are not enough data on urodynamic findings in these patient groups. In our study, it was aimed to determine the results of urodynamic-pressure flow study of patients being admitted to our clinic with LUTS and having neurological disease, and to compare these findings according to neurological pathology.

## MATERIALS AND METHODS

After getting approval from the Tekirdağ Namık Kemal University Local Ethics Committee (no: 2022.180.10.04, date: 25.10.2022), the data of 2,489 patients who underwent urodynamic evaluation in our clinic between 2010 and 2022 were evaluated retrospectively. Patients with neurological diagnoses at the time of urodynamic analysis were identified and included in the study. Patients without neurological disease

or repeated urodynamics for the same patient despite having neurological disease were excluded from the study. Initial urodynamic reports were taken as reference from recurrent urodynamic results. Neurological diagnoses of the patients were compared with the data in the automation program (Enlii, v3.23.01.1, 2015, Turkey) and in the neurology clinic, and patients with incompatible diagnoses were excluded from the study. Among the urodynamic findings, first urine sensation, maximum bladder capacity, filling phase overactivity, filling phase maximum detrusor pressure, bladder compliance ( $>30$  cmH<sub>2</sub>O for non-neurogenic,  $>40$  cmH<sub>2</sub>O for neurogenic is considered nomocompliant;  $<10$  cmH<sub>2</sub>O for neurogenic,  $<30$  cmH<sub>2</sub>O for neurogenic were considered hypocompliant) and, if any, evacuation phase parameters (maximum detrusor pressure and flow velocity during the evacuation phase) were evaluated<sup>2</sup>.

Since urodynamic evaluation is an invasive procedure, informed consent forms were obtained from all patients before urodynamic evaluation. Before the procedure, the patients were performed urine culture and those with growth in the culture were treated with the appropriate antibiotic according to the antibiogram, and all urodynamics were performed with sterile urine. In order for the abdominal pressure catheter to work optimally, fleet enemas were routinely applied to the patients one day before the procedure. Urodynamic evaluations were performed with the Aymed brand (version: 19050010-03, 2019, Turkey) aqueous system urodynamic device, accompanied by a trained urodynamic nurse. In adult patients, during the filling phase, saline fluid warmed to body temperature was sent into the bladder at a rate of 25 mL/hour. In pediatric cases, the infusion rate was adjusted to be one tenth of the patient's expected bladder capacity. The procedure was terminated by performing a pressure flow study in the patients deemed necessary. The amount of residual urine before and after each procedure was evaluated using a catheter. All urodynamic data used in the study were performed in the same clinic by an experienced urodynamic team, in accordance with international urodynamic standards.

## Statistical Analysis

After the descriptive analysis of the data in the study, they were given as mean and standard deviation. To compare the quantitative data of the two groups, the normality test was performed with the Shapiro-Wilk test. Normally distributed parametric data were evaluated with the Student's t-test, and non-parametric data were evaluated with the Mann-Whitney U test. The chi-square test was used to compare the qualitative data within the groups. The results were within the 95% confidence interval, and the  $p < 0.05$  value was considered as statistically significant.

## RESULTS

A total of 598 patients with a diagnosis of neurological disease at the time of the first urodynamics in our clinic, whose history and diagnoses were compatible with the patient registry system, were included in the study. The urodynamic data of patients with diseases (tethered cord disease, vascular dementias, Arnold Chiari malformation, neuromyelitis optica, Guillain-Barré syndrome, cauda equina syndrome, autoimmune encephalitis, etc.) with a total number of patients below 10 were excluded from the study. As a result, urodynamic data of a total of 535 patients were evaluated. The mean age of the patients was  $52.69 \pm 15.86$  years, and 321 (60.0%) were female and 214 (40.0%) were male. When the neurological diagnoses of the patients were evaluated, cervical and lumbar disc disorder was detected in 204 (38.1%) patients, MS in 103 (19.2%) patients, Cerebrovascular event (CVE) in 74 (13.8%) patients, spinal cord injury (SCI) in 48 (8.9%) patients, polyneuropathy in 43 (8.0%) patients, Parkinson's disease (PD) in 30 (5.6%) patients, diabetic neuropathy in 18 (3.4%) patients, and operated spina bifida (oSB) in 15 (2.8%) patients. The clinical and demographic characteristics of the patients are shown in Table 1. When the patients were evaluated according to their age, it was observed that the most advanced age group was in Parkinson's patients

( $65.03 \pm 8.62$  years), while the youngest patients ( $45.75 \pm 16.04$ ) were in the SCI group.

In the evaluation of urodynamic filling stage data according to neurological disease groups, it was observed that the first urine sensation of the patients did not differ according to the disease variety, but there was a statistical difference in maximum cystometry capacity (MCC) and maximum detrusor pressures. In the subgroup analyses, it was noted that the difference in maximum cystometry capacity was due to oSB patients and Parkinson's patients, and it was lower than in other patient groups ( $p < 0.001$ ). Among the existing neurological diseases, oSB was observed to have the lowest maximum cystometric capacity. When the maximum detrusor pressures were evaluated according to the neurological diseases, it was observed that the maximum detrusor pressures of the oSB patients reached the highest level among the existing neurological diseases, while the MS patient group was at the second highest level (Table 1).

In the evaluation of compliance disorder, which is an important variable for upper urinary tract damage, it was determined that 66.7% of the patients with a history of oSB had hypocompliance, while this rate was followed by Parkinson's patients with the rate of 40% (Table 2).

Considering the filling phase detrusor activity, it was found that neurogenic detrusor overactivity was at the highest rate in patients with oSB (80.0%) and at the lowest rate in patients with polyneuropathy (23.3%). Neurogenic detrusor overactivity was observed in 50% of diabetic patients with both peripheral and central nervous system damage. When the pressure flow studies of the patients were evaluated, the presence of acontractile detrusor was detected in 104 (17.4%) patients. Although acontractile detrusor was observed in 75 (14.0%) of these patients during the filling phase, neurogenic detrusor overactivity was detected. It was observed that the patient group with the highest rate was the SCI group. Details of the distribution of patients according to their diagnoses are shown in Figure 1.

**Table 1. Comparison of urodynamics+pressure flow study according to neurogenic diagnoses**

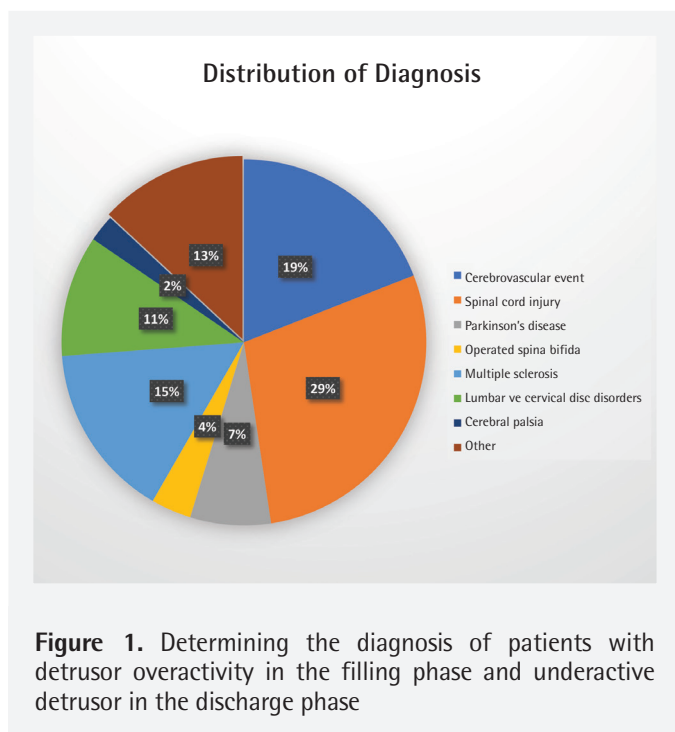
Neurological diseases	Number (n)	Age (year)	First urination sensation (mL)	Maximum cystometric capacity (mL)	Maximum Pdet in filling phase (mmHg)
CVE	74	$62.09 \pm 12.56$	$64.81 \pm 43.06$	$385.19 \pm 165.98$	$23.67 \pm 24.86$
MS	103	$45.95 \pm 10.55$	$80.48 \pm 82.32$	$424.45 \pm 194.38$	$45.30 \pm 44.34$
Diabetic neuropathy	18	$62.44 \pm 10.26$	$44.28 \pm 29.22$	$429.22 \pm 141.49$	$17.58 \pm 11.52$
Parkinson's	30	$65.03 \pm 8.62$	$86.00 \pm 68.76$	$308.70 \pm 190.25$	$23.63 \pm 24.86$
Polyneuropathy	43	$60.27 \pm 13.94$	$55.40 \pm 39.07$	$447.67 \pm 168.03$	$17.27 \pm 15.80$
Operated spina bifida	15	$52.66 \pm 40.78$	$63.50 \pm 39.63$	$264.80 \pm 140.25$	$52.66 \pm 40.78$
Lumbar disc disorders	153	$54.41 \pm 12.72$	$65.31 \pm 40.53$	$491.90 \pm 167.49$	$16.39 \pm 15.73$
Cervical disc disorders	51	$59.38 \pm 14.21$	$61.22 \pm 38.54$	$425.58 \pm 131.25$	$18.79 \pm 14.18$
Operated lumbar and cervical fracture	48	$45.75 \pm 16.04$	$59.41 \pm 31.34$	$474.52 \pm 186.92$	$31.00 \pm 34.97$
<b>p value</b>		$<0.001$	$<0.401$	$<0.001$	$<0.001$

CVE: Cerebrovascular event, MS: Multiple sclerosis

**Table 2. Comparison of neurogenic detrusor overactivity and bladder compliance status data according to the etiology of neurogenic diseases**

Neurogenic diseases	Urge attack		Bladder compliance		
	Yes (n, %)	No (n, %)	Hypocompliant (n, %)	Normocompliant (n, %)	Hypercompliant (n, %)
CVE	33 (44.6)	41 (55.4)	11 (15)	60 (80.9)	3 (4.1)
MS	67 (65.1)	36 (34.9)	29 (28.1)	68 (66)	7 (6.9)
Diabetic neuropathy	9 (50)	9 (50)	4 (22.3)	13 (72.2)	1 (5.5)
Parkinson's	17 (56.7)	13 (43.3)	12 (40)	17 (56.7)	1 (3.3)
Polyneuropathy	10 (23.3)	33 (76.7)	9 (20.9)	24 (55.8)	10 (23.3)
Operated spina bifida	12 (80)	3 (20)	10 (66.7)	5 (33.3)	0 (0)
Lumbar and cervical disc disorders	49 (24.01)	155 (75.98)	22 (10.8)	151 (74)	31 (15.2)
Operated lumbar and cervical fracture	26 (54.2)	22 (45.8)	9 (18.8)	32 (66.7)	7 (14.6)
<b>p value</b>	<0.001		<0.001		

CVE: Cerebrovascular event, MS: Multiple sclerosis



**DISCUSSION**

When the neurological diagnoses of the patients who applied to our clinic with LUTS and a concomitant neurological disease were evaluated, it was determined that the patients with disc disorders, MS and CVE were the most common. In a study conducted in the United States, it was reported that the most common factors in patients admitted to the urology clinic due to LUTS associated with neurological disease were CVE, MS, and SCI, respectively<sup>3</sup>. These findings have similar characteristics and show that LUTS is seen quite frequently, especially in patients with MS and SCI. Disc disorders were the most common neurological disease group seen in our series. In the literature review, there is no significant study showing

the relationship between disc disorders and LUTS. When the epidemiological studies of neurological diseases are examined, it is seen that lumbar and cervical disc disorders are not often included in the neurological disease groups, and the studies that have been conducted are generally based on pathologies such as MS, CVE, and SCI<sup>4,5</sup>. In this context, we think that our series provides important data in terms of showing that disc disorders can also cause LUTS.

Detrusor pressures in the filling phase are important both for the clinical findings of the patients and for possible upper urinary tract damage. It was observed that the disease groups with the highest maximum detrusor pressure in the filling phase consisted of OSD and MS patients, respectively. Maximum detrusor pressures were found to exceed 40 cmH<sub>2</sub>O in these patient groups. Similar findings have also been shown in studies<sup>6</sup>. In addition to high detrusor pressure, bladder compliance is also important in terms of upper urinary system function. In a patient with low bladder compliance, intravesical pressures may remain high and this may cause upper urinary system dysfunction. In our study, it was determined that the group with the most common hypocompliant bladder was oSB patients, followed by the PD group. oSB patients were found to be the riskiest group in terms of upper urinary system due to both high detrusor pressures and low compliance. Similar data have been shown in other studies, and it has been reported that the development of end-stage renal disease in oSB patients is approximately 8 times higher than in the normal population<sup>7</sup>. It has been shown that patients with SCI have high bladder pressures and low compliance, and in this patient group, it is known that the cause of death was related to end-stage renal failure at a rate of approximately 50% in the past years and it has decreased to below 10% today with the development of treatment options<sup>8-10</sup>. In our study, hypocompliance was detected in approximately 20% of patients with SCI, while

maximum detrusor pressures were observed to increase to an average of 31 cmH<sub>2</sub>O. These findings were seen at a lower rate compared to similar studies, and we think that this is due to the early evaluation of patients with SCI (3-12 months) in our clinic and therefore, the first urodynamic evaluation was performed at a time when bladder compliance was not yet affected. Although maximum detrusor pressures were found to be high in patients with MS, only about one-third of them were observed to have impaired compliance. Studies have shown that although detrusor pressures are high in MS patients, the upper urinary system is not affected<sup>7</sup>. We think that this may be due to the fact that compliance is not deteriorated in MS patients and that high detrusor pressures do not occur in a long time.

It has been found that detrusor pressures are low in patients with polyneuropathy manifested by peripheral nerve damage, and compliance is impaired in only 10% of cases. Among the neurological disease groups, the group in which hypercompliance is most common includes the patients with peripheral nerve damage. In this patient group, the risk of upper urinary tract damage is less, and we believe that this may be related to low intra-bladder pressure and not significantly affected compliance. Detrusor overactivity was observed in half of the patients with diabetic neuropathy, while normoactive bladder was detected in the other half. This shows that a pathology that is normally expected to cause peripheral nervous system damage also has a central effect.

### Study Limitations

Although the retrospective nature of our study is one of the main limitations, we believe that prospective collection of urodynamic data in our clinic will reduce this limitation. Since the total number of patients with a group of diseases was less than 10, the exclusion of these groups from the study can be considered as another limitation. However, we think that these diseases are not sufficient to make scientific interpretations due to the lack of numbers. The fact that the urodynamic data used in the study belong to studies conducted in the same clinic by an experienced urodynamic team in accordance with international urodynamic standards represents the strength of the study. In addition, we think that our study is valuable in terms of presenting regional data, since there are not enough data on this subject in our country.

### CONCLUSION

Since patients with oSB and patients with SCI are at high risk for end-stage renal disease, clinicians should take these into consideration when creating a follow-up protocol, especially in these two disease groups, and share possible near and long-term complications with patients and their relatives.

### Ethics

**Ethics Committee Approval:** The study was approved by the Tekirdağ Namık Kemal University Local Ethics Committee (no: 2022.180.10.04, date: 25.10.2022).

**Informed Consent:** Informed consent forms were obtained from all patients before urodynamic evaluation.

**Peer-review:** Externally and internally peer-reviewed.

### Authorship Contributions

Surgical and Medical Practices: Ç.D., M.A., C.M.Y., A.M., E.A., Concept: Ç.D., M.A., C.M.Y., A.M., S.Ş., H.S.D., E.C.T., Design: Ç.D., C.M.Y., E.A., S.Ş., E.C.T., Data Collection or Processing: Ç.D., M.A., E.A., S.Ş., H.S.D., E.C.T., Analysis or Interpretation: Ç.D., M.A., C.M.Y., A.M., H.S.D., Literature Search: Ç.D., A.M., E.A., S.Ş., H.S.D., E.C.T., Writing: Ç.D., M.A.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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