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Mini Review

Urodynamic Risk Factors for Urinary Infection

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Abstract

Urinary tract infections (UTIs) are frequently associated with lower urinary tract dysfunction (LUTD). Urodynamic investigation (UDI) is the gold standard for assessing LUTD, but its value in identifying UTI risk factors remains underexplored. Studies have shown high rates of storage and voiding dysfunction in patients with recurrent UTIs, suggesting a causal link between LUTD and UTIs. Specific UDI findings, such as low bladder capacity, high detrusor pressures, and detrusor overactivity, have been associated with greater UTI risk, especially in kidney transplant recipients and infants. However, the current evidence is limited by the lack of control groups and therapeutic interventions, making it difficult to draw definitive conclusions. Further well-designed studies are needed to determine if UDI-guided therapies can improve UTI management outcomes.

Patient summary: Urinary infections are often linked to problems with the lower urinary tract. Tests that measure lower urinary tract function can help in identifying these issues. More research is needed to see if treating bladder problems can prevent urinary infections.

Lower urinary tract dysfunction (LUTD) and neurogenic LUTD (NLUTD) are widely regarded as risk factors and potential underlying causes for urinary tract infection (UTI). These conditions share a complex of lower urinary tract symptoms (LUTS) that include urgency, frequency, and urinary incontinence. Although urodynamic investigation (UDI) with or without videography is the gold standard and only objective measure for assessing LUTD, studies evaluating its value in identifying risk factors and its potential impact on diagnostic and therapeutic options in UTI patients are scarce.

Two studies [1,2] evaluated UDI findings in subjects with recurrent UTIs and no anatomic abnormalities of the lower urinary tract (n = 221) and found high proportions of patients with storage (39–51%) and voiding dysfunction (41–63%). On the basis of these results, the authors concluded that there is a causal relationship, suggesting that recurrent UTIs are a consequence of LUTD. UDI was pro-

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Table 1 – Urodynamic findings from the studies included in the review

Study and design	Population	Urodynamic signs, % (*n*/*N*)		
		Filling cystometry	Pressure-flow study [c]	Videography
Hijazi 2016 [1] Prospective cohort study	Females with recurrent UTI (*n* = 54)	DO: 28 (15/54) IBS: NA Low compliance: NA SUI: 39 (21/54)	DSD/DV: 17 (9/54) Low outflow: 63 (34/54)[d] DU: 22 (12/54) PVR: 54 (29/45)	VUR: NA
Aliaev 2013 [2] Cohort study	Patients with chronic cystitis (*n* = 116) or chronic PYN (*n* = 51)	DO: – Cystitis: 9 (10/116) – PYN: 35 (18/51)IBS: NA SUI: NA	DSD/DV: 25 (29/116) Low outflow: 41 (47/116)[d] DU: 39 (20/51) PVR: NA	VUR: NA
Shimizu 2020 [3] RCS	Patients with a kidney transplant with (*n* = 41) or without (*n* = 122) UTI	DO: NA IBS:[a] – With UTI: 64 (15/41) – Without UTI: 18 (22/122)Low compliance: NA SUI: NA	DSD/DV: NA Low outflow: NA DU: NA PVR: 15 (6/41)/7 (8/122)	VUR: o With UTI: 20% (8/41) o Without UTI: 12% (14/122)
Bachelard 1998 [4] Cohort study	Infants with first time UTI (*n* = 158)	DO: 64 (101/158) IBS: NA Low compliance: 0 (0/158) SUI: NA	DSD/DV: 83 (131/158) Low outflow: NA DU: NA PVR: NA	VUR: 20% (31/158)
Shigemura 2019 [5] RCS	SCI patients on CIC with (*n* = 41) or without (*n* = 100) febrile UTIs [e]	DO: 45 (61/135) IBS: 80 (113/141)[b] Low compliance: 21 (29/135) SUI: NA	DSD/DV: 44 (60/135) Low outflow: NA DU: NA PVR: NA	VUR: 3% (4/138)

CIC = clean intermittent self-catheterisation; DO = detrusor overactivity; DSD/DV = detrusor sphincter dyssynergia/dysfunctional voiding; DU = detrusor underactivity; IBS = impaired bladder sensitivity; NA = not available; PVR = postvoid residual volume; PYN = pyelonephritis; RCS = retrospective cohort study; SCI = spinal cord injury; SUI = stress urinary incontinence; UTI = urinary tract infection; VUR = vesicoureteral reflux.

[a] IBS defined as a strong desire to void <150 ml.

[b] IBS defined as no urination desire, feeling of abdominal distension, or creepy feelings.

[c] No exact definition for PVR was provided in any of the studies.

[d] Low outflow was defined as a maximum flow rate of <15 ml/s.

[e] UDI findings are reported for the combined overall cohort.

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posed as the diagnostic method of choice, particularly for evaluating voiding disorders such as functional obstruction and detrusor underactivity. UDI was recommended as a test to identify causal therapies for the underlying problems in this patient group. However, the study designs, with no control group or therapeutic measures, meant that these conclusions could not be further substantiated.

In a cohort of kidney transplant recipients (n = 163) with and without UTIs, Shimizu et al [3] found that storage and voiding dysfunctions were associated with higher risk of UTI. They suggested inclusion of functional tests of the lower urinary tract in patient evaluations. A maximum bladder capacity of <150 ml before kidney transplantation was identified as the only significant risk factor identified via UDI, with a hazard ratio of 2.335 (95% confidence interval 1.214–4.49; p = 0.011) after stepwise selection in multivariate analysis. A detailed analysis revealed that voiding dysfunction was defined on the basis of a need for catheterisation for bladder emptying and not on UDI parameters.

Bachelard et al [4] investigated UDI patterns in infants with UTIs and examined how infections influenced UDI parameters. They found that UTIs significantly altered UDI profiles. Infants with vesicoureteral reflux (VUR) were typically infrequent voiders with significantly elevated residual urine volumes. Male infants exhibited high voiding detrusor pressure and low bladder capacity, while female infants had elevated voiding pressure levels, although lower than in males. These pressures were even higher when the UDI was delayed after the UTI, suggesting that high pressures can elevate the risk of pyelonephritis. Detrusor overactivity was found in two-thirds of the infants. The study highlighted the role of UDI, as LUTD in children is typically not apparent to parents or medical professionals.

Regarding patients with NLUTD, Shigemura et al. [5] explored associations between abnormal UDI and cystography findings with febrile UTIs in a retrospective cohort study of 141 spinal cord injury patients performing clean intermittent catheterisation. They found that UDI confirmed NLUTD in nearly every patient, regardless of past febrile UTIs. Apart from severe bladder deformity identified via cystography findings, none of the UDI parameters, including low bladder compliance, detrusor sphincter dyssynergia, and detrusor overactivity, were significantly associated with febrile UTIs. The authors attributed this lack of association to potential bias due to therapeutic interventions in both groups, which may have affected the UDI findings.

Table 1 presents an overview of the UDI findings from the different studies discussed. Figure 1 provides insights into a typical case involving a patient with NLUTD and recurrent febrile UTIs. Relevant attributes described in the aforementioned studies, including UDI signs of detrusor overactivity and low bladder volume during filling cystometry, high postvoid residual volume after incomplete bladder emptying following a pressure-flow study, and cystographic signs of bladder deformity and VUR, are present. These findings potentially explain the underlying cause of recurrent UTIs and highlight specific therapeutic target points for risk reduction for this patient.

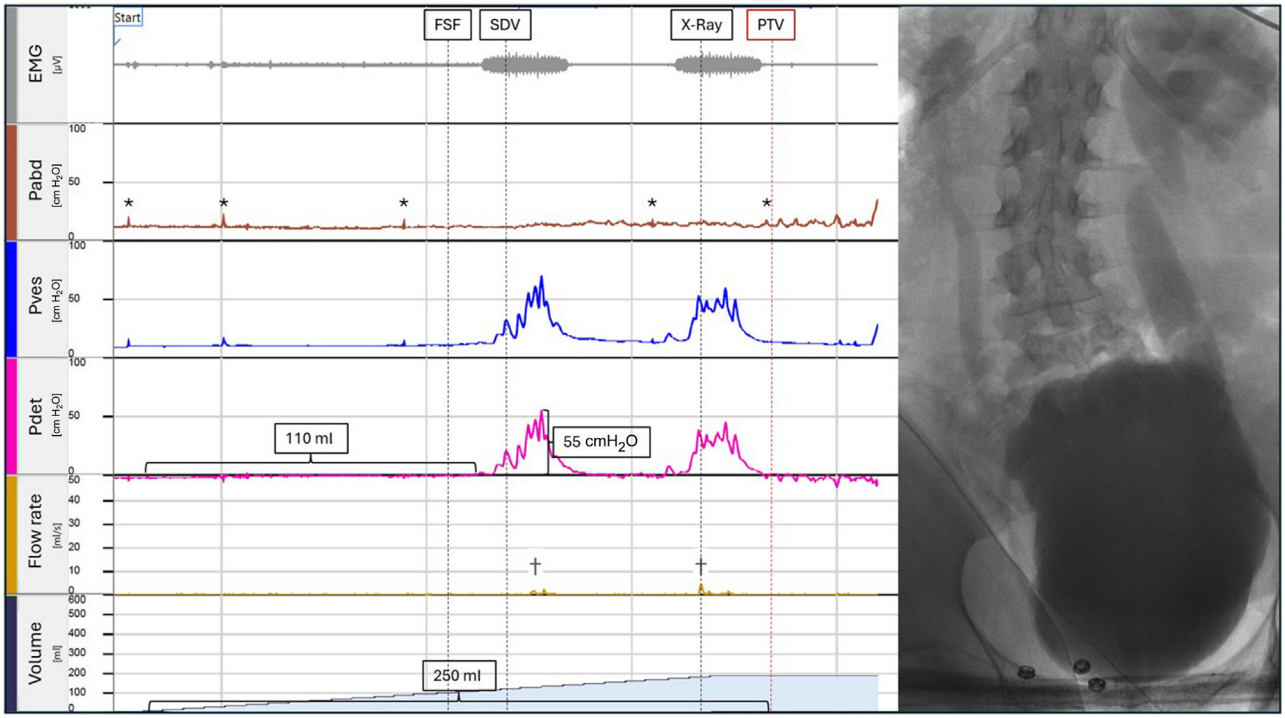

Fig. 1 – Videourodynamic investigation for a 52-yr-old female with recurrent febrile UTIs and NLUTD due to multiple sclerosis (Expanded Disability Status Scale 8.5). The patient requires a suprapubic catheter for bladder drainage. UDI reveals early-onset detrusor overactivity at 110 ml with high detrusor storage pressure (55 cm H_2O), detrusor overactivity incontinence, and an overall low bladder capacity (250 ml). After leakage of a total of 60 ml, no micturition could be initiated, and the postvoid residual volume was 190 ml. Videography shows multiple (pseudo-)diverticula at the bladder dome and bilateral reflux (grade IV). An association between high-pressure reflux and febrile UTI is possible. Intradetrusor Onabotulinumtoxin A injections are planned as the next therapy step. EMG = electromyography; FSF = first sensation of filling; NLUTD = neurogenic lower urinary tract dysfunction; Pabd = abdominal pressure; Pdet = detrusor pressure; PTV = permission to void; Pves = vesical pressure; SDV = strong desire to void; UDI = urodynamic investigation; UTI = urinary tract infection; * = cough; † = urinary leakage.

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Overall, UDI can plausibly provide insights into the causes of UTIs or highlight LUTS that are not due to infections but rather to LUTD in various patient groups. However, the current body of evidence does not offer clear conclusions. All the studies available lack either a control group or a treatment intervention, and none has a study design that allows for definitive answers. Well-designed diagnostic studies are crucial to determine whether a UDI-guided therapy for LUTD in various UTI populations could improve management outcomes.

Conflicts of interest: The authors have nothing to disclose.

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