



The Role of Urodynamics in the Pre-transplant Evaluation of Renal Transplant

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Abstract

Purpose of Review The goal of this study is to delineate the role of advanced urologic evaluation with urodynamics prior to renal transplantation. We seek to report on its indications, possible findings, and subsequent treatment pathways.

Recent Findings This body of literature is largely comprised of retrospective, single-site studies. Patient selection for urodynamics can be determined based on patient history and voiding symptoms. Many of these renal transplant patients have urodynamic abnormalities such as decreased bladder capacity and compliance. Appropriate treatment of these abnormalities allows for average rates of graft survival.

Summary Urodynamic evaluation is not needed in every renal transplant recipient. However, in patients with oliguria or bladder dysfunction, urodynamics can often reveal significant pathology. The well-selected patient with lower urinary tract symptoms may also benefit from urodynamic evaluation. Treatment options are widely variable, from observation to reconstructive surgery, and should be based on the patient and urodynamic findings.

Keywords Renal transplant · Urodynamics · End-stage renal disease

Introduction

Successful renal transplantation requires a pre-operative assessment of the genitourinary tract to identify a continent reservoir and establish a urinary tract free of infection, urolithiasis, malignancy, anatomic malformations, and dysfunctional voiding [1, 2, 3]. Functional assessments of the urinary tract are an important component of this workup. Abnormalities may range from occult lower urinary tract symptoms to severe bladder dysfunction which is the etiology of the patient's end-stage renal disease (ESRD). An effective evaluation identifies patients who could benefit from management prior to transplantation to decrease the risk of donor allograft loss; it has been shown that bladder pathology does not inherently place a patient at higher risk of graft failure given appropriate pre-transplant evaluation and management [2]. Urodynamics

(UDS) represents the most comprehensive assessment of the function of the lower urinary tract. In this review, we discuss the role of the urodynamics in the pre-transplant evaluation of renal transplant candidates.

Methods

We performed a PubMed search from 1965 to 2018 to identify all modern publications related to urologic evaluation prior to renal transplant, focusing on urodynamics. We limited our search to original studies and review articles in the age of immunosuppression. Key words used were “urodynamics,” “urologic evaluation,” “bladder capacity,” and “lower urinary tract evaluation” in combination with “kidney transplant” or “renal transplant.” Citing articles of the identified studies were reviewed as well.

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History of Functional Urologic Evaluation in Renal Transplant

The routine workup of pre-transplant patients begins with a history, physical examination, urinalysis, and abdominal

imaging [4]. Bladder function is assessed, at a minimum, with post-micturition bladder ultrasound to evaluate residual volume and uroflowmetry [2]. Additional imaging such as kidney, ureter, and bladder X-rays or computed tomography have been obtained at the provider's discretion [1•]. If voiding abnormalities are suspected such as bladder dysfunction, benign prostatic hyperplasia, or urethral stricture disease, then the indicated management pathway is recommended prior to waitlist placement for renal transplantation [1•].

Voiding cystourethrogram (VCUG) provides anatomic evaluation of bladder contour and capacity as well as the presence of ureteral reflux or outlet obstruction. VCUG was previously used in the urologic evaluation of patients prior to transplant depending on surgeon protocol; however, recent literature supports its specific use only in patients with a previous urologic history, current abnormal urinalysis/urine culture, or ongoing urinary symptoms [5, 6].

Since the advent of urodynamics, urologists are better able to quantify bladder function. Urodynamics has now become an integral part of the pre-transplant workup. In 2014, the European Association of Urology (EAU) renal transplantation guidelines identified urologic evaluation of transplant candidates as necessary with UDS being a key component for patients with an abnormal urogenital tract (Grade B/C Recommendation) [7].

Urodynamic Techniques

Urodynamic evaluation is considered the standard method of evaluating bladder function in patients with dysfunctional or defunctionalized bladders prior to renal transplantation. The dynamic study helps elucidate how the bladder stores and evacuates urine. Urodynamic findings that may necessitate intervention include poor compliance, dyssynergia of the external or internal sphincter, longstanding high-pressure detrusor overactivity, and high storage pressures [8]. Before proceeding with a urodynamic evaluation, it is necessary to determine the specific findings of interest in order to help appropriately design the study. Components of the urodynamic studies include uroflowmetry, cystometry, pressure flow study, voiding cystourethrography, and optional concomitant fluoroscopic evaluation. A multichannel urodynamic or fluoroscopic urodynamic study consists of the following components:

1. Filling cystometry
2. Electromyography
3. Uroflowmetry
4. Post-void residual
5. Urethral pressure profile
6. Pressure flow studies

7. Optional imaging of the lower urinary tract (video-urodynamics, most commonly fluoroscopy)

Fluoroscopic evaluation aids clinicians in identifying specific sites of obstruction, identifying the presence and grade of vesicoureteral reflux and the associated urodynamic parameters present at time of reflux, and the identification of anatomic and physical abnormalities of the bladder, bladder neck, and urethra [9]. In patients with neurogenic bladders, video-urodynamics is the gold standard method of evaluating the lower urinary tract [10]. In urological causes of renal failure such as longstanding bladder outlet obstruction, the addition of fluoroscopy to pre-transplant urodynamic studies may help identify stricture disease, ureteral reflux, bladder trabeculation, or other anatomic pathologies that could threaten the viability of the renal allograft. Fluoroscopy carries with it an additive risk of radiation exposure, and consequently, should be performed in a manner that maximizes clinical information while minimizing patient exposure.

The oliguric nature of renal transplant candidates presents a challenge for obtaining reliable UDS results due to decreased flowmetric data. Bladder cycling has demonstrated utility in determining the underlying cause of the defunctionalized bladder and involves filling the bladder via cystostomy followed by voiding [1•]. This allows for a longer voiding phase thereby producing more quantitative data for interpretation of the UDS [11].

Bladder Pathology in End-Stage Renal Disease

Potential renal allograft recipients may have a host of urological conditions that require workup as part of the pre-transplantation evaluation. Dysfunctional bladders prior to renal transplantation may have reduced maximal bladder capacities, exhibit detrusor overactivity, or reduced bladder compliance [12, 13]. The decrease in urine output associated with renal failure may mask bladder function abnormalities. In addition, functional abnormalities such as loss of bladder capacity may actually occur from long-term disuse due to anuria or oliguria. A study of pre-transplant men without urologic diagnoses found a urodynamic decrease in bladder functional volume, capacity, and maximum flow during the voiding phase. This was most apparent for patients with daily voided volumes below 750 mL, in patients above 55 and in patients who were on dialysis for greater than 1 year [14]. As part of the pre-transplantation history, patients should be evaluated for urinary tract infections, a history of hematuria, urolithiasis, urinary incontinence, acute urinary retention, pelvic radiation history, and irritative or obstructive voiding symptoms. For patients with a history of lower urinary tract symptoms or diseases, there is a significant prevalence of bladder pathology

on further evaluation which is best addressed prior to transplant.

Renal failure and oliguria appear to increase the risk of bladder pathology. This is attributed to an increase in hypertonicity in the absence of normal filling cycles, which may then be compounded by fibrosis which further decreases compliance and capacity [15]. Zermann and colleagues urodynamically evaluated 52 patients in renal failure and reported a high incidence of lower urinary tract dysfunction in this patient population. Lower urinary tract dysfunction was noted in 77% of men studied. The specific urodynamic abnormalities included bladder hypersensitivity (31%), poor compliance (38%), detrusor instability (25%), and detrusor-sphincter dyssynergia (33%) [12]. Other studies have reported decreased bladder capacity and compliance in ESRD as well with up to 65% of patients having abnormal findings [16, 17].

For pediatric patients, bladder pathology is a common etiology of ESRD. Posterior urethral valves (PUV) is the underlying pathology in approximately 8% percent of pediatric transplant patients in recent reports [18], with neurogenic bladder such as in spina bifida and severe reflux comprising the other functional causes of ESRD [19]. In these three cases, patients may develop urodynamic findings of low bladder compliance; patients with PUV are also at risk for poor bladder contractility, while spina bifida patients are at risk of detrusor-sphincter dyssynergia, which are associated with progression to ESRD [20]. Patients with spina bifida in particular can present with varying degrees of neurogenic bladder dysfunction that can also change over time, necessitating careful monitoring into adulthood [21].

Overall, current literature suggests that urodynamic evaluation should be obtained in all patients with end-stage renal disease reporting problems of bladder storage or emptying, including all patients with neurogenic bladder. For some patients, urinary symptoms are not present due to oliguria or anuria, defined as 300 cc or less of urine production per day. For these patients, a functional urologic evaluation is recommended. In the absence of oliguria and urinary symptoms, a urodynamic evaluation may not need to be performed as part of the pre-transplantation workup [1, 4] (Fig. 1).

Management of Urodynamic Diagnoses

In many patients, urodynamic evaluation will reveal pathology and the provider must be prepared to act upon these results. In a series of 44 consecutive patients referred for pre-transplant urodynamics, 68% of patients were found to have significant pathology which required intervention prior to patients proceeding with transplant [22]. This is especially true for patients for whom urologic abnormalities are the etiology of their ESRD. Here, we describe the therapeutic options available to providers.

Observation

In many patients, bladder function spontaneously improves following transplant. Wu and colleagues evaluated the urological complications in 41 anuric kidney transplant recipients who were on hemodialysis for more 10 years or longer prior to kidney transplantation and compared this cohort to a control of 31 patients who were never on hemodialysis and had normal bladder function [23]. Although associated with a greater probability of complicated urinary tract infections, even small defunctionalized bladders regained normal volume within weeks of transplantation. Several studies have similarly found that the decrease in compliance and bladder capacity seen in neurologically intact adult transplant patients normalizes in the 6 months to 1 year following transplant, without further intervention [24, 25]. In a long-term study comparing transplant in abnormal bladders due to congenital abnormalities, NGB, or urethral stricture to controls, Salman and associates found an increase in urologic complications and infections, but comparable graft survival at 5 years (82% vs 87%). This decreased to 63% at 10 years in patients with abnormal bladders compared to 83% of controls, although the small sample size precluded any statistical comparison between these outcomes [26].

For patients with urologic etiology for ESRD, this is a more difficult management decision. Some authors have proposed that pre-transplant observation can be a viable treatment approach for these patients provided they have close post-transplant urologic follow-up and plan for further intervention should there be evidence of threat to the graft [27].

Conservative Measures

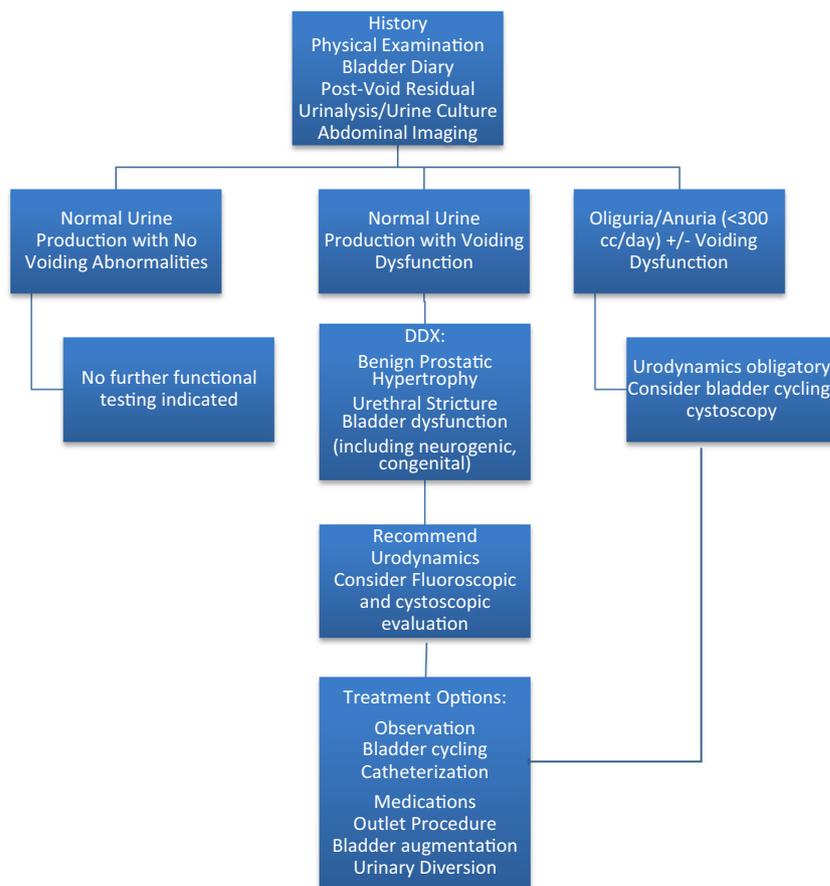
Bladder Cycling

In addition to its use in diagnosis of lower tract pathology, bladder cycling has been offered as a treatment option for small defunctionalized bladders prior to transplant [28, 29]. However, given reports of increased bladder capacity after transplantation as described, there is a growing consensus that this may not be required prior to transplant [30].

Catheterization

Catheterization, either with intermittent technique or suprapubic tube placement, can be instituted pre-transplant based on urodynamic findings. This is most common in the setting of neurogenic bladder or pediatric bladder pathology. With careful monitoring and compliance, these strategies have been shown to allow for safe transplantation [31].

Fig. 1 Functional assessment pathway in patient evaluation prior to renal transplantation



Medical Management

Oral medications remain an option for urinary obstruction according to standard pathways [32]. Patients with poor bladder compliance may also benefit from intravesical chemodenervation with OnabotulinumtoxinA (OnabotA). Although its efficacy has not been studied in the ESRD population specifically, OnabotA has been demonstrated to increase bladder capacity by approximately 160 mL in patients with neurogenic bladder [33]. These patients would also likely need repeat urodynamic evaluation following OnabotA injection to ensure bladder pressures have been adequately lowered to a safe threshold.

Surgical Management

Outlet Procedure

Male patients with undiagnosed BPH prior to surgery are at higher risk for catheterization following transplant and UTI, especially in patients over age 60, a risk that is mitigated by pre-transplant diagnosis and treatment of outlet obstruction with medical and surgical management as needed [5, 34]. However, we would not recommend TURP in the anuric

patient given the risk of urethral stenosis from dry resection bed. Outlet procedures have been described in the post-transplant setting without increased risk to graft [35].

Urinary Reconstruction

Pre-transplant bladder augmentation has been most frequently reported in the pediatric population. Historically, patients with bladder dysfunction received bladder augmentation or diversion prior to transplant to improve graft survival [36–39]. However, urinary reconstruction with augmentation or ileal conduit has associated risks of metabolic abnormalities, malignancy, and infections, among others [19]. Some authors argue that this is not necessary as many patients will have improved capacity following transplant; those who do not respond can be treated as indicated [40, 41]. In a careful review of urodynamic parameters that would indicate significant lower urinary tract dysfunction, Riley and associates recommend reconstruction for the well-selected pediatric patient with a fibrotic or scarred bladder, diagnosed by having low cystometric bladder capacity with poor compliance and reflux with no improvement with bladder cycling. They agree that the timing of surgical intervention is influenced by the degree of pathology; for patients with mild or moderate bladder

impairment, they advocate for proceeding with transplant and addressing the bladder subsequently if needed [42].

Conclusion

Most contemporary literature shows equivalent outcomes for renal transplantations in the setting of bladder pathology provided there is adequate pre-transplant evaluation and treatment, whether pharmacologic or surgical [36, 42–44]. Urodynamics is a vital part of pre-transplant evaluation for patients with urologic pathology as the etiology of ESRD as these patients are most likely to require intervention to allow for safe transplantation. It has been shown to be a valuable part of the evaluation of patients with lower urinary tract symptoms or other urologic history, and may be useful in patients with prolonged oliguria and anuria.

Compliance with Ethical Standards

Conflict of Interest Temitope Rude, Nima Nassiri, Aurash Naser-Tavakolian, and David Ginsberg each declare no potential conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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