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The Role of Urodynamics in the Potential Recipients of Kidney Transplantation

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A B S T R A C T

Urodynamics plays a vital role during the pre-transplant evaluation of potential kidney transplant recipients. This evaluation is useful in diagnosing existing urologic conditions and increasing the success rate of the transplantation through proactive management that can reduce the risk of long-term complications. This paper explains the role of urodynamics prior to kidney transplantation (KT) by elaborating on the rationalization of testing on the potential KT recipients. In addition, it reviews some recommendations from recent studies. Until now, scholars still seek an agreement regarding the criteria of patients that must perform a formal urological evaluation using urodynamics before undergoing a transplant. Studies reported mixed results regarding the criteria, although they generally advocated its usage. Nevertheless, introducing patients with a risk score for urological problems can be an alternative to grouping them before performing urodynamics. This step enables medical staff to group and prioritize patients who need in-depth urological evaluation using urodynamics.

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INTRODUCTION

Kidney transplantation is considered a safe and effective medication for patients with End-stage Renal Disease/ESRD. Nevertheless, short-term or long-term complications are still likely to occur. Besides the delayed graft function, which is generally caused by ischemia or reperfusion injury, severe vascular and urological problems during the early stage after an operation can affect the results in the long run. Some urological complications can be caused by problems in the Lower Urinary Tract/LUT problems, mistakenly diagnosed before the transplant. Today, evaluating urodynamics by examining disorders in the urinary tracts before operation and providing sufficient intervention are perceived as one of the key successes to kidney transplantation.

Kidney failure due to urological disorders happens to approximately 5% of the adult population and 20% of children. In order to identify this disorder, several tests, such as voiding cystourethrography (VCUG), can be conducted prior to kidney transplantations. Previous studies underlined the evaluation of urodynamics before transplantation. This evaluation is intended to avoid allograft dysfunction, which may be caused by chronic bladder dysfunction and the resulting problems.

Most researchers believe a detailed examination of the lower urinary tract should not be performed only in the pre-operation evaluation. Rather, it is recommended to be carried out earlier, such as for dialysis patients awaiting kidney transplantation. However, there is no consensus regarding the criteria of patients who need to perform a formal urological evaluation using pre-transplant urodynamics. Particularly, this is advocated by Rude et al., who revealed that the evaluation of pre-transplant urodynamics was not necessarily conducted for all patients undergoing kidney transplantations. Instead, it should only be directed to those with certain symptoms, such as oliguria or bladder dysfunction. Because several countries have limited resources and deal with health financing challenges, arranging criteria for patients undergoing urodynamics evaluation, including proactive management, is necessary.

Thus, this literature review aims to elaborate on urodynamic roles in the pre-transplant evaluation of potential KT patients. It also summarizes critical recommendations provided by recent studies.

THEORETICAL REVIEW

Kidney transplantation is a life-saving treatment for patients with end-stage renal disease (ESRD). However, the success of transplantation depends not only on the function of the transplanted kidney but also on the recipient's lower urinary tract function. Urodynamic studies play a crucial role in assessing and optimizing the lower urinary tract before transplantation to ensure the long-term health of the transplanted kidney and the patient's overall well-being.

Urodynamics: Definition and Purpose

Urodynamics refers to a set of diagnostic tests that evaluate the function of the bladder and urethra in storing and voiding urine. These studies measure various parameters such as bladder capacity, compliance, detrusor activity, and

voiding efficiency. In the context of kidney transplantation, urodynamic assessments are essential to identify underlying dysfunctions that may affect the graft's functionality post-transplantation.

METHODOLOGY

A literature review was conducted by searching pieces of literature that were published between 2018 and 2023. The literature was obtained from international databases like PubMed and Google Scholar. Several keywords were employed, such as "urodynamics," "urologic evaluation," "bladder capacity," "lower urinary tract evaluation," "kidney transplant," and/or "renal transplant." Following that, references from relevant papers were also screened to identify studies that can be used in this research. It involved prospective and retrospective designs, focusing on the use of urodynamics testing on patients of ESRD. The process of the literature search is summarized using PRISMA.

Literature Research

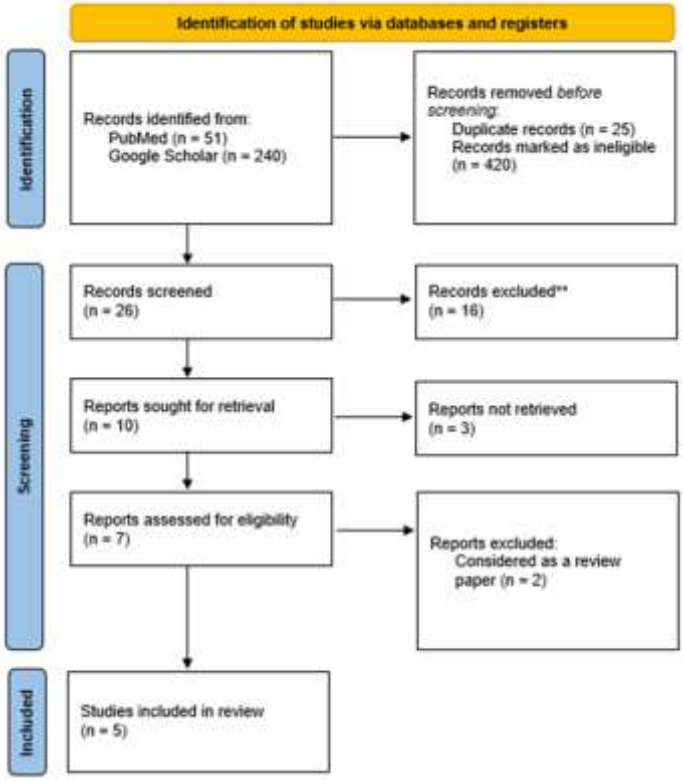

Figure 1. The Flow of Literature Research

Figure 1. summarizes the process of the literature research in this study. From two selected databases, 471 studies were identified. Data duplications were then removed and excluded because they were relevant to the current study's purposes. As a result, ten relevant studies were screened following the study purposes. Seven studies met the criteria, but two were presented as a review paper. Thus, only five studies were provided in this literature review, published from 2018 to 2023.

RESULTS AND DISCUSSION

The Test Procedures and Indication of Urodynamics

Urodynamics is generally defined as the measurement to examine whether or not the Lower Urinary Tract/LUT is functioning through various methods. The purpose is mainly to observe and interpret these measurements clinically. It intends to identify symptom factors and measure related pathophysiological processes. The American Urological Association (AUA), Society for Urodynamics, Female Pelvic Medicine, and Urogenital Reconstruction (SUFU) categorize the main indication to perform a urodynamics study into five groups: 1) identifying the LUT dysfunction, 2) predicting the consequences of LUT dysfunction on the upper urinary tract, 3) forecasting the management result, 4) assessing intervention results, and 5) evaluating failures through medication.

The International Continence Society (ICS) guideline suggests the protocol of standardized urodynamics that require patients to undergo a holistic clinical examination as a part of the urodynamics investigation. The history of urological symptoms must be recorded, including the patient's medical history and medications. Physical examination is also needed, including relevant neurological evaluation, such as walking, sacral sensation, and reflexes checkings. Female patients must undergo a pelvic examination. Meanwhile, males should check their external genital organs and digital rectal to assess the prostate. Patients investigating LUT symptoms are expected to fill the symptom scores that are relevant and validated, including indicators of disorders in their daily activities. In addition, the patients are requested to complete a 3-day bladder record (volume frequency card) to assist in establishing a urodynamic diagnosis. Urinalysis examination should be done before carrying out urodynamic testing that is invasive.

The multi-channel urodynamic test consists of five components: uroflowmetry, cystometry, pressure flow studies, urethral pressure profile, and electromyography. However, some literature has different components, such as voiding cystourethrography and optional concomitant fluoroscopic evaluation. The optional fluoroscopic evaluation helps doctors identify the specific obstructed location, presence, and level of vesicoureteral and reflux, and associated urodynamic parameters present during reflux. Also, it identifies anatomy and bladder physical disorders, bladder neck, and urethra. For patients with neurogenic bladder, the video-urodynamic is a golden standard for evaluating LUT. A standardized urodynamic report must cover all of the pre-test clinical assessments mentioned above, together with the urodynamic diagnosis and management recommendations.

The Rationalization of Urodynamic Testing in Evaluating Potential Kidney Transplantation Patients

Potential kidney allograft recipients have various urological conditions that should be assessed during the pre-transplant evaluation. Prior to the kidney transplant, individuals with bladder dysfunction may experience reduced bladder capacity, detrusor overactivity, and decreased bladder compliance. For ESRD patients, bladder dysfunction may be undiagnosed or masked due to the reduced urinary output experienced by these patients. Besides, loss of functional

bladder capacity may occur due to decreased long-term use resulting from anuria or oliguria. This is so for patients with urination volume below 750 cc, aged 55 years, and undergoing dialysis for more than one year. As part of the pre-transplant history review, a history of urinary tract infection, haematuria, urolithiasis, urinary incontinence, acute urinary retention, history of pelvic radiation, and irritative or obstructive voiding symptoms should be asked.

Kidney failure and oliguria have been reported to increase bladder pathological risks. This increase is associated with increased hypertonicity when the normal filling cycle is absent. It can be worsened by fibrosis, causing decreased compliance and capacity. A report in Germany conducted a urodynamic evaluation of 52 patients with kidney failures. The report claimed a high incidence of LUT by 77%. The report also included specific urodynamic disorders, such as bladder hypersensitivity (31%), poor compliance (38%), detrusor instability (25%), and detrusor-sphincter dyssynergia (33%). Other studies also revealed reduced bladder capacity and compliance in ESRD patients, in which up to 65% indicated abnormal findings. Following that, according to Sarier et al. VCUG results found that 19.2% of patients had pathological findings among all adult patients undergoing kidney transplantation .

Since the emergence of the urodynamic test, urological experts can better measure bladder function. Urodynamics has become an integral part of the pre-transplant examination. In 2014, the renal transplantation guideline, the European Association of Urology (EAU), identified urological evaluation of potential transplant patients using urodynamics as the key component for patients with abnormal urogenital tract. However, this recommendation is popular among the pediatric population because congenital disorders are more identified in this population. In addition, scholars have no consensus regarding the urodynamics preview in adult transplant potential patients.

On urological causes of renal failure, such as prolonged bladder obstruction, the use of fluoroscopy in the pre-transplant urodynamic examination can help identify diseases such as strictures, ureteric reflux, bladder trabeculation, or other anatomic pathologies that may threaten the viability of the kidney allograft. However, it is important to note that fluoroscopy has additional risks resulting from radiation exposures, so it should be carried out carefully using clinical information and minimizing exposures to patients. Besides, the oliguric nature of kidney transplant candidates presents a challenge to obtaining good test results due to the decrease of flowmetric data.

Recommendation of Urodynamic Examination on Potential Kidney Transplant Patient

Most studies in the past reviewed by Rude et al. recommended conducting a urodynamic evaluation on all patients with ESRD who experience issues related to bladder filling and voiding, including those with neurogenic bladder. Patients who do not show urination symptoms due to oliguria and anuria are advised to undergo functional urology evaluation. In this case, a urodynamic evaluation might not be necessary during the pre-transplant assessment.

In more recent literature, urodynamic examinations on potential KT patients are still a subject that is open for discussion due to the mixed population characteristics, results, and recommendations in the literature. In addition, there is still no agreement or consensus regarding this topic, especially in adult patients. In this research, five recent studies about the use of urodynamics among kidney transplant patients were gathered and summarized. Most studies (4/5) were retrospective, while the other was prospective. Recommendations resulting from these studies are provided in Table 1.

Table 1. Recommendation of Urodynamic Examination on Potential Kidney Transplant Patient

Authors	Year	Type of Study	Result	Recommendation
Righetto M., et al.	2021	Retrospective	Urodynamics (UD) was performed on 52 patients with LUTS complaints who would undergo kidney transplantation. While 36 patients experienced severe obstruction, 16 had light obstruction.	UD was recommended for patients with LUTS complaints. It was useful to assess medium-severe bladder obstruction that can increase the risk of transplant complications.
Niu, et al.	2019	Retrospective	Pre-transplant UD was not conducted on all kidney transplant patients. 6 out of 17 patients (35%) had post-transplant urological issues that caused potential graft compromise.	UD was needed before the operation to identify the existing urology conditions and avoid unexpected problems after transplantation.
Tangpaitoon & Swatesutipun	2021	Prospective	*Low-compliance bladder* was linear with the DUDI score created by the authors. The DUDI score was also linked to post-transplant results.	DUDI score might be used to replace the role of the UD examination in the low-resource setting. However, a large-scale study is still needed.
Shimizu T, et al.	2020	Retrospective	Urination dysfunctions and or Micturition dysfunction and/or urinary retention disorders increased the risk of UTI in kidney transplant patients.	Bladder function tests, such as uroflowmetry, postvoid residual urine test, and UD, were recommended in kidney transplant candidates.
Sarier M, et al.	2020	Retrospective	According to the VCUG, 19.25 patients had pathological findings in bladder functions despite having no real symptoms.	VCUG should be considered during the regular check-ups of kidney transplants for adult patients. This is even if the etiology of ESRD is not caused by a urological disorder.

Based on the above summary, most studies are in line with the review by Rude et al., where the recommendation for a urodynamic examination on ESRD patients who will undergo kidney transplantation is addressed to patients with

specific conditions related to LUT. 7,12,2 Righetto et al. argued that functional urology was assessed for all potential KT patients aged 50 years and above. Unlike other studies, Sarier et al. recommended the VCUG examination during regular check-ups of kidney transplants for adult patients, even if the ESRD etiology is not due to urological problems. One of the reasons is the masking of urological symptoms in ESRD patients, as mentioned earlier, that cannot be assessed using a conventional evaluation .

In addition, it is interesting to note that several studies have developed simpler scoring and screening methods to classify the urological risks in potential KT patients. The goal is to assess the risk as fast as possible so that the urodynamic examination can be carried out more efficiently based on the score. Tangpaitoon and Swatesutipun developed a clinical prediction model called DUDi: Duration of RRT, Urine volume per day, and Diabetes. Although it still needs better validation, the results show that a higher DUDi score predicts a higher risk of low compliance bladder area under the curve (AUC) 0.87 (95% CI 0.81–0.92)].

CONCLUSIONS AND RECOMMENDATIONS

Urodynamics is crucial during pre-transplant evaluation for potential KT patients. It functions to diagnose the existing urological conditions, optimize transplant success with proactive management, and minimize the risk of long-term complications. Nevertheless, scholars are still at odds regarding which patients need formal urological evaluation with urodynamics prior to transplantation. Results of this review generate mixed results regarding the criteria, although they generally support to use it. Scoring of urological problem risks can be used as an alternative to classifying patients before the urodynamics is performed.

FURTHER STUDY

Future research should focus on creating and validating standardized scoring systems to identify which kidney transplant candidates require urodynamic evaluation. These systems could integrate factors such as patient history, presence of comorbidities (e.g., diabetes, neurogenic bladder), and clinical symptoms to stratify urological risk and optimize resource utilization.

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