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REVIEW

Diagnosis and management of ureteral complications following renal transplantation

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Abstract When compared with maintenance dialysis, renal transplantation affords patients with end-stage renal disease better long-term survival and a better quality of life. Approximately 9% of patients will develop a major urologic complication following kidney transplantation. Ureteral complications are most common and include obstruction (intrinsic and extrinsic), urine leak and vesicoureteral reflux. Ureterovesical anastomotic strictures result from technical error or ureteral ischemia. Balloon dilation or endoureterotomy may be considered for short, low-grade strictures, but open reconstruction is associated with higher success rates. Urine leak usually occurs in the early postoperative period. Nearly 60% of patients can be successfully managed with a pelvic drain and urinary decompression (nephrostomy tube, ureteral stent, and indwelling bladder catheter). Proximal, large-volume, or leaks that persist despite urinary diversion, require open repair. Vesicoureteral reflux is common following transplantation. Patients with recurrent pyelonephritis despite antimicrobial prophylaxis require surgical treatment. Deflux injection may be considered in recipients with low-grade disease. Grade IV and V reflux are best managed with open reconstruction.

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1. Introduction

Annually, more than 40 billion dollars are spent in the United States treating end-stage renal disease (ESRD) [1]. Over 870,000 individuals suffer from the disease, with approximately 400,000 patients managed by dialysis and 172,553 people living with functioning renal allografts [1]. Compared to dialysis, renal transplantation affords patients dramatically improved 5-year survival rates (85.5% *vs.* 35.8%), while costing the health care system nearly three times less [1].

Although kidney transplantation is associated with significant survival and cost benefits, urologic complications after surgery do occur. In 2002, Streeter and colleagues [2] reported an overall major urologic complication rate of 9.2% following 1535 consecutive renal transplants. Ureteral complications were most common with urine leak and obstruction occurring in 2.9% and 3.0% of recipients, respectively. A more recent series of 1670 consecutive transplants published in 2015 found a urologic complication rate of 8% [3]. Urine leak occurred in 1.8% of men and 4% of women, while ureteral stricture formation was observed in 2.4% of male and 1.2% of female recipients. Vesicoureteral reflux (VUR) following transplantation is common with an incidence ranging from 50% to 86% [4,5].

Here we review the etiology, clinical presentation, diagnostic work-up and management of ureteral complications following renal transplantation. Pertinent studies are discussed and recommendations are provided to help guide treatment decisions.

2. Evidence acquisition

A literature search was performed using the PubMed database and the terms "transplant","ureteral stricture", "ureteral obstruction", "urine leak", and "vesicoureteral reflux". Case reports and non-English manuscripts were excluded. Full text case series and their references were reviewed. When feasible, data were combined from multiple series. However, a formal meta-analysis was not possible due to the limited and heterogeneous data available.

3. Evidence synthesis

3.1. Ureteral obstruction

Approximately 1%—4.5% of renal transplant recipients will develop ureteral obstruction at some time after surgery [2,3,6]. Distal obstruction is most common. Ureteral devascularization leading to intrinsic stricture formation is the principle cause in nearly 90% of cases [7]. Technical errors during the ureteroneocystostomy, extrinsic compression (e.g., hematoma, lymphocele, abscess), kinking of a redundant ureter, collecting system hematoma, a stone transplanted with the kidney, and anastomotic edema can be causes of obstruction during the early postoperative (<3 months) period. Late obstruction (>3 months) usually results from ureteral ischemia, but vasculitis secondary to acute rejection, lymphocele, fibrosis from immunosuppressant medications, and ureterolithiasis may also occur.

A variety of recipient, donor and operative details have been evaluated as predictors of ureteral obstruction following transplantation [8]. Allografts with more than two renal arteries and from donors older than 65 years of age are at increased risk [9]. The authors theorized that multiple renal arteries might correlate with "insufficient inferior pole perfusion, producing relative ischemia to the ureter". Prolonged ischemia time and ureteroneocystostomy without ureteral stent placement have also been correlated with stricture formation [8]. Operative parameters not associated with obstruction include retrieval modality (open versus laparoscopic), preservation of the gonadal vessels during donation, and reimplantation technique (intra- *vs.* extravesical) [8].

A kidney transplant recipient rarely develops symptoms of ureteral obstruction unless urinary tract reconstruction was done by pyeloureterostomy or ureteroureterostomy to the native ureter because the renal allograft is denervated. As a result, recipients typically present with an asymptomatic decline in renal function and a decrease in urine output. Less commonly, patients will complain of a dull ache or feeling of fullness over the allograft due to irritation of adjacent peritoneum.

Transplant recipients presenting with an acute decline in renal function should undergo anatomic imaging (Fig. 1). Renal ultrasonography (US) is an excellent study to screen for hydroureteronephrosis. If present, computed tomography (CT) should be considered, especially in the early postoperative period, because of its ability to identify both intrinsic (e.g., ureteral calculus) and extrinsic (e.g., lymphocele, hematoma) sources of obstruction. Collecting system dilation without a clear etiology should prompt a nuclear medicine scan with furosemide washout to confirm the presence of obstruction (Tip: be certain the bladder is empty during the study). Hydroureteronephrosis without blockage is concerning for VUR and a voiding cystourethrogram (VCUG) should be done.

Decompression of the collecting system to minimize allograft injury is the initial priority in recipients with ureteral obstruction. Both ureteral stent and nephrostomy tube placement are options. However, ureteral stent placement is often challenging due to the anterolateral location of the ureteroneocystostomy, anastomotic edema, ureteral tortuosity, and distal obstruction. Consequently, it is the authors' opinion that percutaneous nephrostomy tube placement should be considered first-line treatment in most recipients.

Following decompression, the cause of obstruction must be fully characterized unless it is obvious (e.g., ureteral stone). Antegrade pyelography during nephrostomy tube placement is usually diagnostic (Fig. 2). The location and severity of urine leaks and ureteral strictures can often be defined. On occasion combined antegrade and retrograde contrast studies will be required to accurately determine stricture length. Pyelography should be delayed in patients presenting with a febrile urinary tract infection (UTI) until the infection has resolved.

Obstruction from blood clots within the collecting system and edema of the ureteroneocystostomy will resolve with conservative management. Clot obstruction is usually