Scientific Research Publishing

Open Journal of Urology, 2022, 12, 478-491
https://www.scirp.org/journal/oju
ISSN Online: 2160-5629
ISSN Print: 2160-5440

Long-Term Management of Post-Transplant Ureteral Stricture with Surgical Reconstruction: A Case Series and Literature Review

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How to cite this paper: Reisler, J., Gorman, B., Sonstein, J. and Cicalese, L. (2022) Long-Term Management of Post-Transplant Ureteral Stricture with Surgical Reconstruction: A Case Series and Literature Review. *Open Journal of Urology*, **12**, 478-491.
https://doi.org/10.4236/oju.2022.129047

Received: August 7, 2022
Accepted: September 26, 2022
Published: September 29, 2022

Abstract

Introduction: Ureteral stricture is the most common complication after kidney transplant and is largely responsible for graft dysfunction. Surgical intervention is the definitive treatment if conservative management with stenting and percutaneous nephrostomy tube placement fails and has been shown to have comparable long-term survival rates and limited post-operative complications. Methods: This is a single-center retrospective study following seven patients who received a kidney or a kidney and pancreas transplant between August 2012 and January 2021. These patients underwent surgical ureteral reconstruction after failed conservative management of a ureteral stricture. The reconstruction procedures performed were native ureter to transplanted kidney ureteropyelostomy, native bladder to transplanted renal pelvis vesicopyelostomy, non-transecting side-to-side ureteroneocystostomy, and a Boari flap creation. Data collected from electronic medical records included recipient age, gender, delayed post-transplant complications, ureteral reconstruction technique, and post-reconstruction outcomes. Renal ultrasound (RUS), renogram, nephrostogram, serum creatinine (Cr), and graft biopsy were used to assess for severity of hydronephrosis, ureteral stricture, and graft dysfunction. Serum Cr and RUS were used to assess renal function after the ureteral reconstruction. Results: Six out of seven cases resulted in reduced or resolved hydronephrosis and preserved graft function without future nephrostomy or ureteral stenting. One case required immediate revision due to persistent obstruction, and this patient had concomitant rejection leading to intrarenal stricture requiring ureterocalycostomy. Conclusions: Formal ureteral reconstruction is the definitive treatment for many cases of ureteral strictures after

transplant. The surgical technique chosen for these procedures must consider the physical and functional state of the bladder, ureter, and kidney. Our series outlines multiple surgical approaches that should be considered early in the management of post-transplant ureteral strictures to limit graft dysfunction.

Keywords

Ureteral Stricture, Ureteral Reconstruction, Post-Transplant Complications

1. Introduction

Ureteral complications after kidney transplant are responsible for many cases of graft dysfunction that require multiple interventions and possible graft loss. Ureteral stricture, the most common type of ureteral complication, has been reported to occur in 0.6% [1] - 10.5% [2] of patients after receiving a kidney transplant. These complications have been associated with the use of older donors and the presence of post-transplant delayed graft function [3]. Therefore, with the increased use of elderly and marginal donors as well as increased cold ischemia time (CIT) expected with the new organ distribution algorithms, one should expect this complication to be observed with increased frequency. Initial management of ureteral stricture consists of stenting and/or placing a percutaneous nephrostomy tube (PCN) to divert the urine, but this is not ideal for long-term management. Ureteral dilation may be attempted for shorter strictures, but this often results in recurrence of the stricture. The preferred management for distal strictures has been ureteroneocystostomy. Occasionally, the bladder is not suitable for this procedure, or the stricture is too proximal. Thus, other surgical interventions may be required, such as native ureter to transplant kidney ureteropyelostomy, transplant ureter to native ureter ureteroureterostomy, Boari flap creation, etc., and are selected on a case-by-case basis. These surgical interventions have been shown to have comparable long-term survival rates [4] and limited post-operative complications [5], suggesting that surgical reconstruction is the most effective method for long-term management and that it should be considered early in the treatment course to limit graft dysfunction. We report a case series of seven patients who received surgical intervention due to ureteral stricture recurrence after failed initial conservative management.

2. Methods

This is a retrospective study performed at the University of Texas Medical Branch in Galveston, Texas following seven patients who received a kidney or a kidney and pancreas transplant between August 2012 and January 2021. All patients who underwent surgical ureteral reconstruction at this institution due to the development of a post-transplant ureteral stricture during this time period were included in this study. All seven had hypertension (HTN), and four had

diabetes mellitus type 1 (DMI) or type 2 (DMII). Five patients received tacrolimus and mycophenolic acid (MPA) for immunosuppression maintenance, one received belatacept and MPA, and one received belatacept, MPA, and prednisone. The reconstruction procedures consisted of native ureter to transplanted kidney ureteropyelostomy, native bladder to transplanted renal pelvis vesicopyelostomy, non-transecting side-to-side ureteroneocystostomy, and a Boari flap creation. Data collection was from electronic medical records and consisted of recipient age, gender, delayed post-transplant complications, ureteral reconstruction technique, and post-reconstruction outcomes. Renal ultrasound (RUS), renogram, nephrostogram, serum creatinine (Cr), and graft biopsy were used to assess for severity of hydronephrosis, ureteral stricture, and graft dysfunction. Serum Cr and RUS were also used to assess renal function after the ureteral reconstruction. All procedures were performed with an intraperitoneal approach to avoid dissecting dense pericapsular adhesions and adhesions near the vascular anastomoses, therefore reducing the risk of vascular complications and hemorrhage. Moreover, when utilized, the native ureter on the same side of the graft was always stented preoperatively via cystoscopy, and intraoperative ultrasound (US) was used to identify the transplanted renal pelvis and vascular structures during the surgical dissection prior to reconstruction. All ureteral reconstructions were performed by a surgical team consisting of a transplant surgeon and a urologist at the same institution between November 2012 and March 2021.

3. Cases: Ureteropyelostomy

3.1. Case 1

A 69-year-old female patient with a medical history of DMII, HTN, and recurrent urinary tract infections (UTIs) underwent a cadaveric renal transplant in September 2015 for end stage renal disease (ESRD) secondary to DMII. Her immunosuppressive therapy consisted of tacrolimus and MPA. The ureteral stent was removed three weeks later. The patient had multiple admissions throughout the next three months due to acute kidney injury (AKI) and recurrent UTIs. RUSs and renal biopsies throughout this period showed mild to moderate hydronephrosis of the transplanted kidney and capillaritis, glomerulitis, and thrombotic microangiopathy (TMA), suggestive of mild calcineurin inhibitor (CNI) toxicity.

She was hospitalized three months after the transplant with a Cr of 4.06, and a subsequent nephrostogram showed complete occlusion of the mid-ureter. Due to this occlusion, a balloon ureteroplasty was performed, and a double-J ureteric stent was placed. A nephrostogram taken after stent placement showed free passage of contrast through the stented ureter and into the bladder. Her Cr decreased to 2.97, and she was discharged home.

The PCN and stent were removed three weeks after her discharge, and she was hospitalized three weeks later for AKI. RUS showed stable moderate hydronephrosis of the transplanted kidney (**Figure 1**), and a PCN and stent were

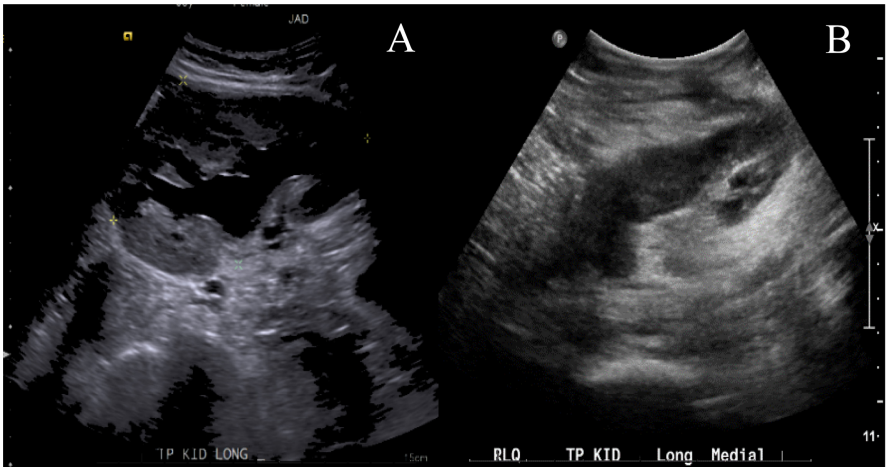

Figure 1. Case 1: RUS before ureteral reconstruction (A) showing stable moderate hydronephrosis and after (B) showing improvement in hydronephrosis.

placed. Subsequent nephrostogram showed free flow of contrast into the urinary bladder through the ureteral stent and the PCN was removed. She was discharged home with a Cr of 2.2.

Five months later, she underwent a right stent exchange. A retrograde pyelogram was performed and showed no filling defects or hydronephrosis of the right native ureter, but the transplanted ureteral orifice showed a stricture preventing the drainage of contrast solution over 20 minutes. The next month, she underwent ureteropyelostomy of the right native ureter to the pelvic transplanted kidney. During this procedure, an intraoperative US was performed to aid in identifying the transplanted ureter. There were no complications, and she was discharged home with a Cr of 1.70.

The ureteral stent was removed two months after the ureteropyelostomy. The patient's most recent RUS taken five months after this reconstruction (**Figure 1**) showed improvement in hydronephrosis. Her kidney allograft function has been consistent since surgery with Cr values remaining around 1.5.

3.2. Case 2

A 30-year-old male patient with a medical history of DMI, HTN, and metabolic bone disease underwent a cadaveric kidney and pancreas transplant in February 2017. His immunosuppressive therapy consisted of tacrolimus and MPA. The ureteral stent was removed three weeks later. He was admitted to the hospital multiple times within the next eight months due to various infections and leukopenia; however, his kidney function remained stable throughout.

He was hospitalized for fever and pancreatitis nine months post-transplant, during which a RUS showed moderate hydronephrosis of the transplanted kidney and renal biopsy showed acute T-cell-mediated rejection, BANFF 1A, for which he was started on thymoglobulin. He had a rise in Cr to 5.37 and was taken to the operating room (OR) for cystoscopy with plans for retrograde pyelogram and possible ureteral dilation. There were unsuccessful attempts via re-

trograde cannulation of the transplanted ureteral orifice to perform a retrograde pyelogram, and, therefore, a PCN was placed. A month into this admission, the patient underwent an internalization of the PCN to a double J stent. His Cr decreased to 1.34, and he was discharged home.

Within the next four months, he was hospitalized multiple times for recurrent UTIs and AKI. He continued to have obstructive uropathy despite Foley catheterization and PCN placement. Additionally, RUS continued to show mild-moderate hydronephrosis and perirenal fluid collection over this period. A month after this last admission, a nephrostogram was performed and showed no passage of contrast past the UPJ, suggesting worsening stricture. The patient was hospitalized the next day for a rise in Cr to 3.86. RUS showed mild hydronephrosis of the transplanted kidney (**Figure 2**), so he underwent a PCN tube exchange and was discharged home the next day with a Cr of 3.72.

Two months after the PCN exchange, he underwent cystoscopy, stent placement into the native ureter, and an exploratory laparotomy with native ureter to transplanted kidney ureteropyelostomy. Nephrostrogram taken on post-operative day one revealed contrast within the renal collecting system with no contrast passing into the ureter, indicating that the ureteropyelostomy was unsuccessful most likely due to the stricture involving the UPJ and renal pelvis. He then went back to the OR for cystoscopy and retrograde pyelogram with revision ureterocalycostomy of the native ureter to the transplanted renal calyx. The PCN tube was removed a few days later, and he was discharged home with a Cr of 4.86.

His Cr values remained in the 4s for the next several months due to chronic rejection. Throughout the next six months, he continued to have elevated Cr > 4 but no hydronephrosis of the transplanted kidney (**Figure 2**). The patient was listed as "active" on the transplant list in UNOS 6 months after his reconstruction, and the ureteral stent was removed within the next few days. His Cr values have remained between 4 - 6 since being listed in UNOS.

3.3. Case 3

A 70-year-old male patient with a medical history of DMII and HTN underwent

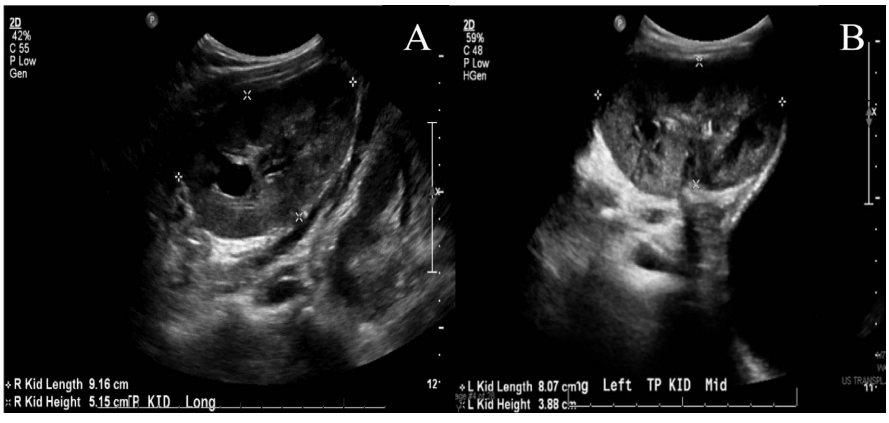

Figure 2. Case 2: RUS before ureteral reconstruction (A) showing mild hydronephrosis and after (B) showing resolved hydronephrosis.

a cadaveric kidney transplant in March 2017 for ESRD secondary to DMII and HTN. His immunosuppressive therapy consisted of tacrolimus and MPA. The ureteral stent was removed one month later. The patient's allograft function had remained stable for the following twelve months.

Within eighteen months post-transplant, he was admitted two times for AKI. During the second admission, RUS showed hydronephrosis of the transplanted kidney, so a PCN tube was placed and then exchanged for a nephroureteral catheter. Nephrostogram showed a high-grade stricture at the UPJ. A renal scan taken the next week showed normal perfusion and adequate excretion with a T1/2 of 14 minutes with the nephroureteral catheter still in place. A week later, cystoscopy showed no prostatic obstruction, the nephroureteral stent was still in place, and his post-void residual was 57cc. The nephroureteral stent was accidentally pulled out three days later and subsequently replaced with a PCN.

During the next twelve months, the patient was admitted multiple times for recurrent UTIs and AKI. Two nephrostograms taken during this time showed UPJ obstruction and ureteral narrowing. CT scans and RUSs continued to show mild-moderate hydronephrosis (Figure 3).

Within thirty months post-transplant, the patient underwent ureteropyelostomy of the right native ureter to the renal pelvis of the transplanted kidney. A ureteral stent was also placed, and the PCN was removed. There were no post-operative complications, and the patient was discharged home with a Cr of 1.96. RUS taken two weeks later with the ureteral stent in place showed resolved hydronephrosis (Figure 3). The ureteral stent was removed one month after the reconstruction. Cr taken five months later was 1.92 and has been stable since this procedure.

3.4. Case 4

A 55-year-old male patient with a medical history of HTN, DMII, HLD, benign prostatic hyperplasia, and CKD underwent a cadaveric kidney and pancreas

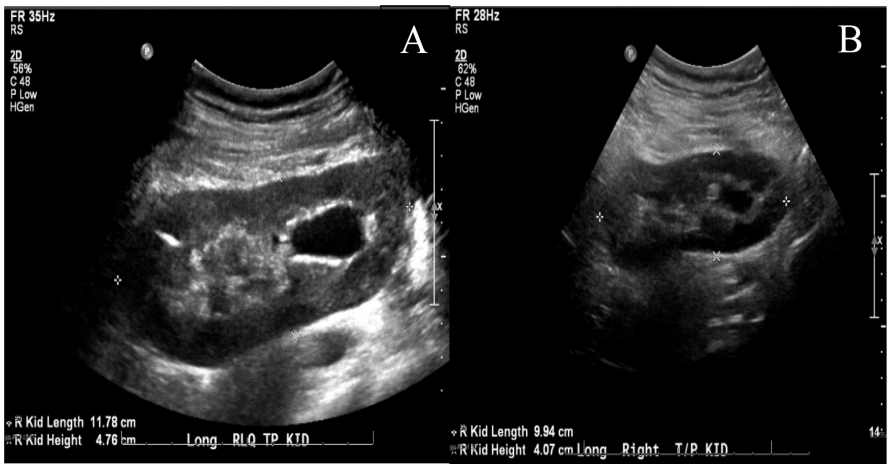

Figure 3. Case 3: RUS before ureteral reconstruction (A) showing mild-moderate hydronephrosis and after (B) showing resolved hydronephrosis.

transplant in April 2017. His immunosuppressive therapy consisted of tacrolimus and MPA. He was discharged home with a Cr of 2.11. Cystoscopy with stent removal was performed six weeks after the transplant. Within the next three months, he was admitted multiple times for intra-abdominal abscess, small bowel obstruction, and enterocutaneous fistula, but his kidney function remained stable throughout this time, and repeat RUSs showed no hydronephrosis.

A CT taken three months after this last admission showed mild hydronephrosis and hydroureter. Subsequent RUS showed hydronephrosis of the transplanted kidney, and a renal biopsy taken three days later showed diffuse interstitial edema consistent with obstruction.

The patient was admitted two additional times within the next two months for AKI. During the first hospitalization, nephrostogram showed a high grade mid-ureteral stricture and RUS showed moderate hydronephrosis that was resolved with PCN placement. His Cr decreased to 1.56, and he was discharged home. A few weeks later, he underwent balloon dilation and anterograde stent placement. RUS taken a week after showed mild hydronephrosis, and he was admitted within the same month with a Cr of 2.29. Renal Mag3 scan showed normal perfusion and a T1/2 of 30. The ureteral stent was exchanged, and a retrograde pyelogram showed UPJ and proximal ureteral stenosis. RUS taken after the PCN exchange showed no hydronephrosis. He was discharged home with a Cr of 2.85.

He received a PCN tube placement a week later with a Cr of 2.91. Nephrostogram showed mid ureteral stenosis and confirmed the stent placement (**Figure 4**), and RUS showed no hydronephrosis. Approximately one-year post-transplant, he underwent ureteral reconstruction consisting of a left native ureter to transplant kidney ureteropyelostomy. Pelvic US taken two days later showed no hydronephrosis and confirmed correct stent placement (**Figure 4**).

There were no post-operative complications, and he was discharged home with a Cr of 3.45. Cystoscopy with stent removal was performed one month after the reconstruction. Cr taken five weeks later was 2.5 and has been stable since

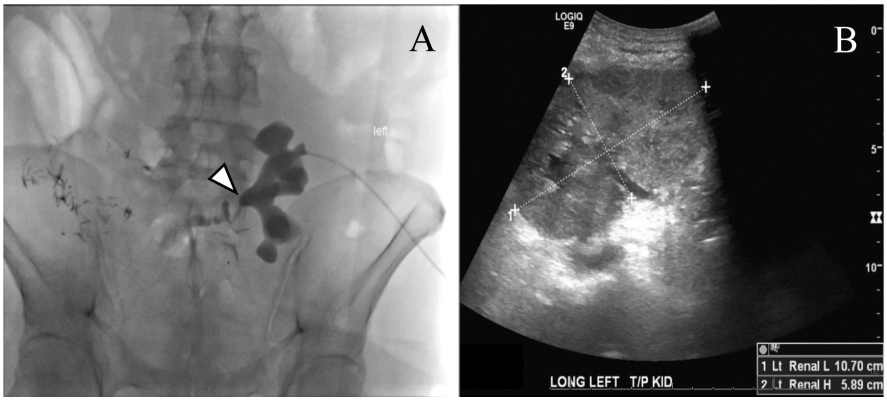

Figure 4. Case 4: (A) Antegrade nephrostogram demonstrating stenosis at ureteropelvic junction (arrowhead) and tortuous transplant ureter before ureteral reconstruction and (B) RUS showing resolved hydronephrosis after reconstruction.

this procedure.

4. Case: Vesicopyelostomy

Case 5

A 62-year-old female patient with a medical history of HTN underwent a cadaveric kidney transplant in February 2016 for ESRD secondary to focal segmental glomerulosclerosis (FSGS). Her immunosuppressive therapy consisted of tacrolimus and MPA. The ureteral stent was removed two months later. Within the next three months, she had multiple admissions for AKI. RUS showed mild hydronephrosis of the transplanted kidney, and renal biopsy showed TMA likely secondary to CNI toxicity. Kidney imaging with renogram performed during this time revealed decreased and delayed perfusion of the transplanted kidney and mild hydronephrosis with a stricture at the ureteropelvic junction (UPJ).

Within five months post-transplant, her Cr increased to 5.8, and a retrograde pyelogram revealed hydronephrosis and a stricture now at the vesicoureteral anastomosis. She then underwent cystoscopy, ureteral dilation, and stent placement with no complications.

The stent was removed five months later, and the patient was hospitalized the next week for AKI. Kidney imaging with renogram and RUS showed moderate hydronephrosis (**Figure 5**) of the transplanted kidney with delayed excretion, likely representing recurrent obstruction at the level of the transplantedureteral vesical junction (UVJ). She underwent cystoscopy and ureteral stent placement. She was discharged home with a Cr of 4.01.

Two months later, the patient underwent a reconstruction consisting of native bladder to transplanted renal pelvis vesicopyelostomy with ureteral stent placement. The procedure had no complications, and she was discharged home with a Cr of 1.33.

The ureteral stent was removed the next month, and a subsequent RUS showed resolved hydronephrosis with only mild residual pelviectasis (**Figure 5**).

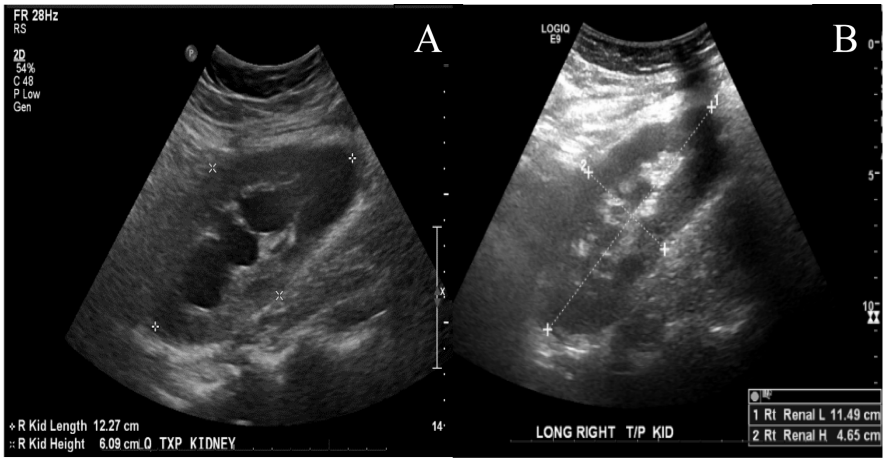

Figure 5. Case 5: RUS before ureteral reconstruction (A) showing moderate hydronephrosis and after (B) showing resolved hydronephrosis.

Her kidney allograft function has been stable since surgery with Cr values remaining around 1.3.

5. Case: Boari Flap

Case 6

A 36-year-old male patient with a medical history of HTN underwent a cadaveric kidney transplant in August 2012 for ESRD secondary to FSGS. His hospital course was complicated by post-operative bleeding, which was ultimately controlled by a blood transfusion and a percutaneous drain. His immunosuppressive therapy consisted of tacrolimus and MPA. Stent removal was scheduled for late August; however, cystourethroscopy showed significant edema at the anastomotic site, and the stent was not removed due to concern for obstruction of the transplanted ureteral orifice by local inflammation. He was admitted that day for pain around the drain and perinephric hematoma. He was discharged home a few days later with a Cr of 1.10.

The stent was removed three weeks after the patient's discharge. He was hospitalized three times within the next two months for AKI. RUS continued to show worsening hydronephrosis of the transplanted kidney. A PCN was placed during the third admission, and a subsequent nephrostogram showed UVJ stricture and anastomotic leak while a RUS showed resolved hydronephrosis. His Cr was stabilized to 1.43, and the patient was discharged home.

He was admitted two weeks later for a ureteral stricture and Cr of 1.62. During this admission and three months post-transplant, Boari flap creation between the transplanted ureter proximal to the stricture and the bladder was performed and a ureteral stent was placed. His Cr was stabilized to 1.3, and the patient was discharged home.

Cystogram performed 5 weeks after the procedure revealed no leak, and the ureteral stent was subsequently removed. RUS performed two months later showed mild but decreased hydronephrosis. Cr has been stable around 1 since the reconstruction.

6. Case: Ureteroneocystostomy

Case 7

A 69-year-old male patient with a medical history of HTN, peripheral artery disease, and previous kidney transplant in 1991 underwent a cadaveric kidney transplant in January 2021 for ESRD secondary to HTN. His immunosuppressive therapy consisted of belatacept, MPA, and prednisone. He was found to have acute tubular necrosis on post-operative day five and continued to have delayed graft function necessitating three sessions of hemodialysis postoperatively. He was discharged home with a Cr of 6.31, and his Foley catheter and JP drain were removed one week later.

Cystoscopy with stent removal was performed three weeks after the transplant, and the patient was admitted to the hospital one week later due to UTI

associated with bacteremia. RUS showed stable moderate hydronephrosis of the left transplant kidney and dilation of the proximal transplant ureter (Figure 6). Cr increased to 8.42 from a baseline of 5. Anterograde nephrostogram showed a severe distal ureteric stricture near the anastomosis. A PCN was placed, which was unable to be converted to a percutaneous nephroureteral stent due to complete obstruction of the ureteral anastomosis.

He underwent ureteral reconstruction consisting of a non-transecting side-to-side ureteroneocystostomy with stent placement within nine weeks after the initial transplant procedure. There were no immediate postoperative complications, and he was discharged home with a Foley catheter, JP drain, intact PCN, and Cr of 1.84. RUS took four days after discharge showed mild hydronephrosis of the transplanted kidney, which was decreased from previous imaging (Figure 6).

The Foley catheter was removed one week after the procedure, and he was hospitalized two days later for increased output from the JP drain. Fluid Cr was suggestive of urine leak. Nephrostogram showed no hydronephrosis or definite leak. The Foley catheter was replaced and the PCN was continued. He was discharged home with a Cr of 1.96. Nephrostogram performed three weeks later showed no leak, and the PCN, JP drain, and Foley catheter were removed. Cystourethroscopy with ureteral stent removal was performed one month after the reconstruction. RUS taken within three months of the reconstruction showed minimal hydronephrosis of the transplanted kidney, and the patient's Cr has remained stable around 2.1 since the procedure.

7. Results

The results of this case series are summarized in Table 1.

Among these seven patients, two of them are female, and five of them are male. The age range of the patients when they received the ureteral reconstruction was 28 - 69, with the average age being 53.1. The range of time between transplant and ureteral reconstruction for these patients was 2.1 - 30.1 months, with the average being 12.7 months.

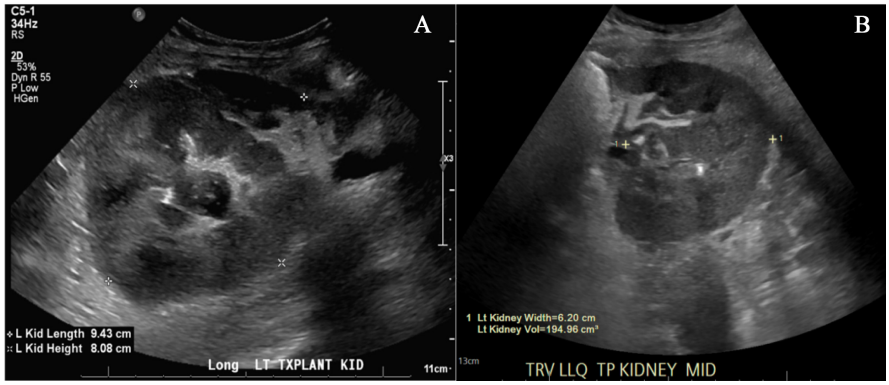

Figure 6. Case 7: RUS before ureteral reconstruction (A) showing stable moderate hydronephrosis and after (B) showing minimal hydronephrosis.

Table 1. Outcomes for the seven Ureteral reconstructions.

Patient #	Stricture Location	Procedure Performed	Outcomes
1	Mid-ureter	R native ureter to transplanted kidney ureteropyelostomy	Mild, but reduced hydronephrosis
2	UPJ	1. L native ureter to transplanted kidney ureteropyelostomy	1. Failed
3	UPJ	2. Revision ureterocalycostomy	2. Resolved hydronephrosis but developed chronic rejection
		R native ureter to transplanted kidney ureteropyelostomy	Resolved hydronephrosis
4	Mid-ureter	L native ureter to transplanted kidney ureteropyelostomy	Resolved hydronephrosis
5	UVJ	Transplanted ureter to bladder vesicopyelostomy	Resolved hydronephrosis
6	UVJ	Boari flap creation	Mild, but reduced hydronephrosis
7	Distal ureter near anastomosis	non-transecting side to side ureteroneocystostomy	Minimal, but reduced hydronephrosis

For all patients, ureteral stricture was suspected due to hydronephrosis and AKI, and later confirmed by nephrostogram or retrograde pyelogram. Two patients presented with a high grade mid ureteral stricture and two with a high-grade occlusion of the UPJ, all requiring ureteropyelostomy for correction. Three patients presented with a stricture at the ureterovesical anastomosis, one requiring a Boari flap, one a vesicopyelostomy, and the last a non-transecting side-to-side ureteroneocystostomy. Six out of the seven reconstructions were initially successful, with one requiring immediate revision due to persistent obstruction. This patient had concomitant rejection leading to intrarenal stricture requiring ureterocalycostomy. One reconstruction was complicated by anastomotic leak, which resolved with conservative management. Hydronephrosis was either reduced or completely resolved as shown by US in six out of the seven patients and these six patients had stabilization of kidney function post-operatively without any additional need for nephrostomy or ureteral stenting. Additionally, renal function in these patients has been preserved since their reconstruction. Unfortunately, renal function continued to decline in one patient most likely due to chronic graft rejection. Despite the successful correction of his obstruction, this patient was placed back on the transplant list in UNOS.

8. Discussion

The primary post-surgical complication rate for kidney transplant is estimated to be 7.1%, with ureteral strictures making up more than 50% of these complica-

tions [6]. Around 90% of early strictures (<3 months after surgery) are due to ureteral ischemia, while other notable causes include external compression from a hematoma or lymphocele as well as technical error. Additionally, late strictures (>3 months after surgery) are predominantly due to ischemic fibrosis, acute rejection, or vasoconstriction causing reduced blood flow as a side effect of immunosuppressants [7]. Risk factors for ureteral stenosis and strictures include donor and recipient age, number of arteries >2, prolonged warm ischemia time, and the presence of post-transplant delayed graft function [3] [8]. Although primary prevention of ureteral strictures is difficult, high-risk patients should undergo consistent monitoring to diagnose and treat this complication as soon as possible [8]. First-line treatment typically involves placement of a PCN, as was done in our seven patients, as well as dilation and stent placement. If these treatments fail, formal reconstruction is indicated. The specific procedure performed depends on many factors, including the length of available ureter, stricture length and location, bladder capacity, and surgeon discretion.

Our patients are complex, with many of them having a history of prior transplant, kidney-pancreas combined transplant, and many co-morbidities, likely contributing to stricture recurrence observed throughout their hospital course. Initial management consisted of stenting and/or PCN placement, while some patients also required ureteral dilation. However, every patient continued to have stricture recurrence post-dilation, independent of stricture location, resulting in multiple hospital readmissions for AKI. For many patients, allograft function was likely affected by recurrent infections and multiple co-morbidities, and no treatment given prior to the ureteral reconstruction was effective in stabilizing and preserving kidney function. Conservative management with dilation failed in all these cases and likely led to a prolonged course containing additional procedures with PCNs and stents, additional admissions, and potential loss of graft function.

Although there is significantly more data involving ureteroureterostomy and ureteroneocystostomy, our case series, as well as the current literature, reports comparable outcomes between these procedures and newer, less common ones, such as ureteropyelostomy and vesicopyelostomy (**Table 2**). Thus, our case series exemplifies potential surgical options that may be utilized when the condition of the ureter or bladder makes ureteroureterostomy and ureteroneocystostomy impractical. For example, Salomon et al. reported a case series in which distal ureteral strictures in nine out of ten patients were corrected with pyeloureterostomy with no evidence of recurrence at two-year follow-ups [9]. Additionally, pyelovesicostomy has been shown to be advantageous when the native ureter is too ischemic or fibrotic for reconstruction [10]. Our study, although small, further supports the use of these surgical procedures on a case-by-case basis. It is advisable to opt for surgical reconstruction early and to use an intraperitoneal approach to minimize graft and anastomotic injury. Performing the reconstruction early also offers the advantage of working with a slightly dilated

Table 2. Comparison of procedures and outcomes between the present study and the current literature.

Author	Number of Patients	Procedures Performed	Complications
Gurkan *et al.* [5]	75	41 ureteroureterostomy, 34 ureteroneocystostomy (Lich-Gregoir technique)	3 recurrent strictures and 2 hematuria in ureteroureterostomy group, 3 vesicoureteral reflux and 1 stent migration in ureteroneocystostomy group
Pike *et al.* [4]	41	Ureteroureterostomy	2 hematuria, 3 ureteral strictures
Riediger *et al.* [11]	16	16 ureteropyelostomy	2 early surgical complications, repaired with Boari flap
Helfand *et al.* [10]	13	6 transplant ureteral re-implant, 1 ureteroureterostomy, 5 pyelovesicostomy, 1 Boari flap creation	Recurrent stricture in 1 ureteral re-implant, 1 Boari flap creation, 1 pyelovesicostomy managed with either chronic stent exchange or balloon dilation
Yang *et al.* [12]	7	2 ureteroureterostomies, 5 pyeloureterostomy	1 ureteroureterostomy developed chronic rejection
Present Study	7	4 ureteropyelostomy, 1 vesicopyelostomy, 1 Boari flap creation, 1 ureteroneocystostomy	1 ureteropyelostomy required revision ureterocalycostomy and developed chronic rejection

renal pelvis that can facilitate easier identification and dissection when performing a ureteropyelostomy. It is also advisable to perform a kidney biopsy intraoperatively at the time of reconstruction to identify and, subsequently, correct other renal graft pathology.

The major limitations of this study are the small sample size and the limited number casesinvolving the various types of ureteral reconstruction. Additionally, there were too few patients to compare the effectiveness and outcomes of each specific type of ureteral reconstruction. Lastly, this study was performed at one institution and needs external validation to assess generalizability. More research needs to be done to sufficiently compare the complication and success rates of these interventions to establish a recommended standardized approach for surgical reconstruction. This is particularly important because with the progressively increased use of marginal donors and longer cold ischemia time, ureteral strictures may be seen with an increased frequency in the future.

9. Conclusion

Ureteral stricture is a common complication of kidney transplantation, for which formal reconstruction is the definitive treatment in many cases. These surgical techniques must be chosen on a case-by-case basis, considering both the physical and functional state of the bladder, ureter, and kidney. Our series outlines a few of the potential surgical approaches that may be performed to treat ureteral strictures, with all resulting in resolved hydronephrosis.

Consent to Publish

Informed consent was obtained from all patients for publication.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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