

5-28-2021

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Recommended Citation

Malinzak L, McEvoy T, Denny J, Kim D, Stracke J, Jeong W, and Yoshida A. Robot-assisted Transplant Ureteral Repair to treat transplant ureteral strictures in patients after Robot-assisted Kidney Transplant: a case series. Urology 2021.

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PII: S0090-4295(21)00444-1
DOI: <https://doi.org/10.1016/j.urology.2021.05.029>
Reference: URL 22960

To appear in: *Urology*

Received date: 11 March 2021
Revised date: 12 May 2021
Accepted date: 17 May 2021

Please cite this article as: Lauren Malinzak , Tracci McEvoy , Jason Denny , Dean Kim , Joel Stracke , Wooju Jeong , Atsushi Yoshida , Robot-assisted Transplant Ureteral Repair to treat transplant ureteral strictures in patients after Robot-assisted Kidney Transplant: a case series, *Urology* (2021), doi: <https://doi.org/10.1016/j.urology.2021.05.029>



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Title Page

Robot-assisted Transplant Ureteral Repair to treat transplant ureteral strictures in patients after Robot-assisted Kidney Transplant: a case series

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Keywords: transplant ureter stricture, robot assisted transplant ureter repair, robot assisted kidney transplant, kidney transplant, case series

Abstract:

Objective: To describe the use of robotic-assisted transplant ureteral repair (RATUR) for treating transplant ureteral stricture (TUS) in 3 patients who had undergone robot assisted kidney transplant (RAKT).

Method: We reviewed the medical records of 3 patients who experienced TUS after RAKT and who underwent RATUR between 2017 and 2020. The patients' RAKT, post-transplant clinical course, endourological interventions, reoperation, and recovery were assessed.

Results: All patients diagnosed with TUS presented with deterioration of kidney function after RAKT. Method of diagnosis included ultrasound, antegrade ureterogram, and CT scan. All 3 patients had a short (<1 cm) area of TUS and underwent RATUR. For 2 patients, distal strictures were bypassed with modified Lich-Gregoir ureteroneocystostomy reimplantation. One patient was treated with pyelo-ureterostomy to the contralateral native ureter. No intraoperative complications, conversions to open surgery, or significant operative blood loss requiring blood transfusion for any patient were observed. Also, no patients had urine leaks in the immediate or late postoperative period. After RATUR, 2 patients developed Clavien grade II complications with rectus hematoma or urinary tract infection.

Conclusion: RATUR is a technically feasible operation for kidney transplant patients with TUS after RAKT. This procedure may provide the same benefits of open op-

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eration without promoting certain comorbidities that may occur from open surgical procedures.

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Introduction:

The prevalence of transplant ureteral stricture (TUS) after open kidney transplant with Lich-Gregoir technique using a stent is 1.5% to 5.6% [1-3]. The incidence of TUS after robot-assisted kidney transplant (RAKT) is not well studied.

At our single institution, 85 patients underwent RAKT between June 2014 and June 2020. Of these patients, 4 experienced TUS after RAKT, an overall prevalence of post-RAKT TUS of 4.7%. One patient with a short-segment distal stricture was successfully treated with endourological management, the remaining 3 patients required surgical treatment and received robot-assisted transplant ureter repair (RATUR).

In this series, we describe 3 phases of care for 3 patients who underwent treatment: RAKT, diagnosis of TUS and endourologic intervention, and robot-assisted transplant ureter repair (RATUR). We present these cases to highlight complex treatment strategies, which should aid kidney transplant teams in recognizing TUS and encourage consideration of newer surgical strategies.

Materials and Methods:

We reviewed the medical records of 3 patients who experienced TUS after RAKT and who underwent RATUR. The patients' RAKT, post-transplant clinical course, endourological interventions, reoperation, and recovery were assessed. [Table 1]

Results:

Patient 1 was a 65-year-old woman with end stage renal disease (ESRD) caused by diabetes. She spent 9 months on peritoneal dialysis prior to RAKT.

Phase I RAKT: RAKT was performed similarly for all 3 patients. The patients underwent general anesthesia with endotracheal intubation, supine positioning in modified lithotomy with 15 degrees of Trendelenburg, broad spectrum antibiotics, and placement of a 3-way urinary catheter. The DiVinci Xi robot was docked between the patient's legs. A GelPoint was placed at the umbilicus via a 6 cm incision. Under direct visualization with a 30-degree camera, two 8 mm ports were placed in a horizontal line to the left of the Gelpoint. One 8 mm port was placed 5 cm to the right of the GelPoint. A 5 mm assistant port was placed in the right upper quadrant. The operation was completed with the Vattikuti Urology Institute-Medanta RAKT technique [4]. All patients had a left live-donor kidney placed into the right lower quadrant.

This donor kidney had a single artery and vein. The kidney was stabilized in the retroperitoneum under peritoneal flaps. Baseline creatinine after transplant was 0.8 ml/dL. Demographic information and details of RAKT for the 3 patients are listed in Table 1.

Phase II Diagnosis of TUS and endourological intervention: Patient 1 had a rise in her creatinine from 0.8 to 4.5 mg/dL at 4 months after transplant. An ultrasound showed hydroureter and a biopsy showed borderline acute cellular rejection. She was treated with methylprednisolone sodium succinate (Solu-medrol) intravenous 250 mg for 3 days. She underwent placement of a percutaneous nephrostomy tube and antegrade ureterogram, which showed a short segment distal ureteral stricture. The distal ureter

was dilated by balloon to 5 mm and an internal stent was placed. Her creatinine improved and the nephrostomy tube was removed.

The stent remained for 12 weeks, but after removal, the hydronephrosis returned; therefore, a second percutaneous nephrostomy tube and ureteral stent were placed. CT scan (figure 1) revealed the hilum of the kidney was oriented posterolaterally with the ureter tracking medially around the kidney and into the bladder. Plans were made for RATUR but were delayed for medical management of new onset seizure.

Phase III RATUR: The surgical set-up for RATUR was the same as for RAKT, except that the assistant port was placed higher in the right upper quadrant to avoid injuring the transplanted kidney.

Upon entering the abdominal cavity, the dilated transplant ureter with an indwelling stent was visualized with minimal dissection into the paravesicle space. Because the patient was female, no cord structures or vas deferens obscured the ureter. The ureter was verified by using Firefly fluorescence imaging after indocyanine green (ICG) injection. The ureter was opened longitudinally for 1.5 cm proximal to the stricture. A cystotomy was made next to the original implantation site on the bladder. The ureter was reapproximated to the cystotomy using poliglecaprone 25 suture (Monocryl), bypassing the stricture. The stent was exchanged for a 6 Fr x12 cm JJ ureteral stent. The patient was discharged on post-operative day 1 with an indwelling Foley catheter for 10 days and ureteral stent for 6 weeks. Follow-up ultrasound after stent removal showed a mild hydronephrosis and the patient's creatinine was 1.6 mg/dL.

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Patient 2 was a 45-year-old man who had ESRD due to IgA nephropathy and was on peritoneal dialysis for 3 months prior to RAKT.

Phase I RAKT: This donor kidney had two arteries and an extrarenal pelvis. The two arteries were syndactylized prior to implantation. The medial umbilical ligament was divided, and the transplant ureter was run under the spermatic cord then implanted into the bladder using a modified Lich-Gregoir technique with 5-0 polydioxanone suture (PDS) for the mucosal anastomosis and 4-0 V-lock for the seromuscular tunnel. A 6 Fr x 12 cm JJ ureteral stent was placed through the anastomosis. Intraoperative ultrasound showed that attempts to place the kidney in a retroperitoneal position impeded the parenchymal blood flow. Hence, the kidney was placed in the medial and intraperitoneal position.

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Phase II Diagnosis of TUS and endourological intervention: Patient 2 had a rise in creatinine from 0.98 mg/dL to 1.58 mg/dL 1 month after his stent was removed. Ultrasound showed moderate hydronephrosis. Ureteral imaging showed compression of the ureter at the ureteropelvic junction with a normal caliber distal ureter. An 8 Fr percutaneous nephrostomy tube was placed then exchanged for an internal stent. Creatinine levels returned to baseline, and the stent was removed 12 weeks later. The patient's creatinine remained stable for 5 months until he was admitted with bilateral pulmonary emboli. At this time, his creatinine was 1.6 mg/dL and he received a second percutaneous nephrostogram. Antegrade ureterogram showed a dilated pelvis and proximal ureter thought to be consistent with extrarenal pelvis. The flow of urine was slow but flowed unobstructed into the bladder. No gradient measurements to differentiate obstructive

from non-obstructive uropathy were performed. No dilation or stent placement was performed.

After 4 months, the patient was readmitted with pyelonephritis and a creatinine level of 2.3 mg/dL. He required placement of a third percutaneous nephrostomy tube. Antegrade nephrostogram showed partial obstruction of the proximal ureter as it exited the extra-renal pelvis. An internal stent was exchanged for the percutaneous nephrostomy tube. CT scan (figure 2) showed that the kidney was lying transversely with the hilum of the kidney pointing posteriorly and the ureter coursing around the lateral edge of the vas deferens and spermatic cord before entering the bladder. Surgical intervention was delayed due to the ongoing need for anticoagulation therapy for bilateral pulmonary emboli.

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Phase III RATUR: This position of the kidney created a proximal obstruction in the ureter as it exited the extra renal pelvis. Surgical plan was made to bypass the obstruction by creating a pyelo-ureterostomy with the contralateral native ureter. The contralateral ureter, as opposed to ipsilateral ureter, was chosen because the position of the kidney juxtaposed the extrarenal pelvis and the contralateral ureter and was away from previous area of dissection. Use of the native ureter by means of its natural anti-reflux mechanism should help prevent further pyelonephritis[5, 6].

Upon entering the abdomen, the paravesicle space was identified. The renal pelvis was identified at the inferior aspect of the transplant. The left native ureter was identified as it crossed the common iliac artery and dissected to the medial umbilical ligament, ligated proximally, and divided. The distal portion of the ureter was tunneled through the peritoneum on the posterior bladder wall and spatulated. An anastomosis

was created between the ureter and the transplanted kidney renal pelvis with 4-0 PDS. A 6 Fr x 14 cm JJ stent was placed across the anastomosis. Postoperatively, the patient developed a rectus muscle hematoma in his port site, which was related to his need for anticoagulation therapy. He was discharged home in good condition after 11 days and his creatinine returned to 1.1 mg/dL.

Patient 3 was a 65-year-old man with ESRD due to myeloproliferative glomerulonephritis and a solitary kidney. He was on hemodialysis for 3 years prior to RAKT.

Phase I RAKT: This donor kidney had a single artery and vein. The kidney was stabilized in the retroperitoneum. The path of the ureter was from the kidney laterally, under the spermatic cord, to the bladder medially. The medial umbilical ligament was divided. The ureter was implanted using a modified Lich-Gregoir technique with 5-0 PDS for the mucosal anastomosis and 4-0 V-lock for the seromuscular tunnel. A 6 Fr x 12 cm JJ ureteral stent was placed through the anastomosis.

Phase II Diagnosis of TUS and endourological intervention: Ten days after his stent was removed, the patient's creatinine increased from 1.2 to 5.1 mg/dL. Ultrasound evaluation of the transplanted kidney showed moderate hydronephrosis. CT of the abdomen and pelvis showed an oblong 1.8 cm calculus present at the ureterovesical junction. The urologists were unable to dislodge the calcification or place a retrograde ureteral stent during cystoscopy. Biopsy of the ureteral obstruction showed fibrous tissue with calcified debris. Interventional radiologists placed a percutaneous nephrostomy tube and antegrade ureteral stent. The patient's creatinine returned to 1.2 mg/dL, and after 8 weeks, his stent was removed, and his creatinine remained stable at

1.2 mg/dL for approximately 2 months. When his creatinine started rising again, he underwent percutaneous nephrostomy tube placement, ureteral stent placement, and endoscopic balloon dilation. The stent was removed after 6 weeks; but within 2 weeks his creatinine rose again, and he returned for a third percutaneous nephrostomy tube and stent placement. However, stenosis was severe, and the stent could not be placed. He was discharged with an open percutaneous nephrostomy tube. Non-contrast CT scan (figure 3) showed that the dilated ureter was adjacent to the bladder. RATUR was delayed due to local COVID-19 levels.

Phase III RATUR: For patient 3, the transplant ureter was dissected within the paravesicle space, taking care to avoid injury to hilar vessels of the transplant kidney and the cord structures. ICG was administered and the renal pelvis and ureter were verified using Firefly fluorescence imaging.

A longitudinal incision was made in the ureter and the area of stricture was opened to remove the calcifications imbedded into the suture line of the prior anastomosis. A cystostomy was made in the bladder. Bladder mucosa and ureteral mucosa were brought together with 4-0 PDS over a 6 Fr x 12 cm JJ ureteral stent. Interrupted 3-0 polyglactin suture (Vicryl) was used to form a seromuscular layer. After the surgical procedure, the patient had fever and urinary tract infection caused by *Citrobacter* and *Morganella* species, and he was treated with ciprofloxacin. His Foley catheter remained for 7 days and his stent remained for 22 days. His post-procedure creatinine was 1.1 mg/dL.

Collectively, the 3 patients described here experienced no intraoperative complications, conversions to open surgery, or significant blood loss requiring blood transfu-

sion during RAKT or RATUR. During RAKT, the median (range) operative time was 323 (253-408) minutes. All patients had immediate graft function. Hospital length of stay was 3 days for patient 1, 5 days for patient 2, and 16 days for patient 3 because of postoperative sepsis from *Candida glabrata*. The mean (range) duration of stenting after RAKT was 20 (16-26) days. For RATUR, the median (range) operative time was 172 (122-223) minutes. Hospital length of stay was 1 day for patient 1, 12 days for patient 2 because of rectus muscle hematoma and anticoagulation, and 4 days for patient 3 because of urinary tract infection. The median (range) of urinary catheterization was 6 (1-10) days. The median (range) duration of stenting after RATUR was 38 (22-49) days. Patient care timeline is outlined in supplementary figure 1.

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Comment:

In this case series, we highlighted 3 detailed cases of short-segment TUS arising after RAKT and treated with RATUR. When TUS occurs, unobstructed urine flow needs to be restored to preserve function of the transplanted organ. Multiple challenges such as maintaining continuity of care, prompt and accurate diagnosis, preoperative planning, intraoperative repair, and minimization of postoperative complications are highlighted by these cases.

Discussion:

First, taking a united and collaborative approach to diagnosis and patient care is necessary because multiple strategies for handling TUS exist. The team should agree upon a unified plan of care. Whereas certain delays to reoperation were unavoidable (seizures, coumadin, COVID-19), opportunities to avoid prolonged endourological intervention when surgery should have been offered also exist. For example, patient 2 underwent a percutaneous antegrade pyelogram where the result was a false negative; the test failed to diagnose the stricture. A Whittaker test, which measures a pressure gradient, may have helped to clarify the diagnosis and shorten the duration prior to reoperation.[7] In patient 3, earlier dilation may have eliminated repetitive procedures. Delays can be detrimental because multiple interventions and chronic obstruction can lead to inflammation and thickening of the ureter making intra-operative identification and dissection of a ureter more challenging. The transplant surgeon should remain central in a patient's care because early surgical intervention has been found to be associated with better long-term graft survival [8-10].

Endourological treatment can be successful in short-segment ureteral stenosis but is rarely definitive [3, 11]. Surgery provides a more durable repair. Strictures that are identified late and those with long strictures >3 cm likely require surgical treatment. Each patient in our series underwent diagnosis by antegrade pyelogram, endourologic placement of a temporary percutaneous nephrostomy tube, balloon dilation, and internal stent. Endourologic procedures are forefront in diagnosis of transplant ureter stricture and often serve as a bridge to surgery.

Preoperative planning, including review of the ureterogram and CT, is used to diagnose the site, position and extent of the stricture. Review of the transplant operative

note will help the physician determine the anatomy and sidedness of the donor kidney, the side of the implantation, the medial or lateral lie of the kidney, and whether it lies intraperitoneally or retroperitoneally. Synthesizing this information helps understand the orientation of the kidney, renal pelvis and ureter and aids in planning for reoperation [12].

Options for reoperation depend on the TUS location and symptoms of vesicoureteral reflux. Most strictures occur distally, at the site of the anastomosis, and are caused by inflammation, rejection or ischemia. A short, distal stricture can usually be reconstructed with a repeated ureteroneocystostomy. Concerns with this approach include distal ureteral dissection into scar tissue, reflux, lack of clarity on how much to resect, loss of length, ongoing ischemia and restenosis [12, 13]. Asymptomatic VUR is common after ureteroneocystostomy, 0-86%, and the vast majority, 98%, is asymptomatic [12, 14]. VUR occurs after ureteroneocystostomy regardless of tunneling and without confounding factors such as bladder dysfunction is not a risk factor for urinary tract infection, loss of graft, loss of graft function or decreased survival[14-17]. Patients 1 and 3 underwent redo ureteroneocystostomy, neither of which had shown any signs or symptoms of reflux. The amount of scar tissue in the paravesicle space was minimized by its intraperitoneal location. Tension on a redo ureteroneocystostomy can be reduced by bladder mobilization or psoas hitch. Boari flap may be used when there is significant loss of the length of the ureter[18]. Proximal and mid-ureteral stricture can occur from the extrinsic compression from the cord structures, ischemia, ureter injury at time of recovery or as in patient 2, from positioning of the transplant kidney. His presentation included pyelonephritis and although he was not evaluated for VUR prior to re-

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operation, native ureter was chosen for reconstruction. Use of the distal native ureter in uretero-urostomy or pyelo-ureterostomy can prevent a wide, refluxing anastomoses due to its natural anti-reflux mechanism. It also more amenable to post-surgical endoscopic procedures[12].

Surgeons need to be ready for intraoperative challenges. Identifying the ureter in the paravesicle space can be the challenging as it may be thickened or affected by a desmoplastic reaction due to chronic obstruction, or previous surgical or endoluminal manipulation. RAKT is an intraperitoneal surgery hence the ureteral anastomosis remains intraperitoneal. If the kidney is placed completely retroperitoneally, such as in an open kidney transplant, the surgeon must also dissect through the peritoneal layer to identify the ureter. Multiple strategies exist for locating the ureter. A standard or illuminated stent in the transplant ureter can differentiate it from the surrounding tissue. ICG with Firefly fluorescence imaging can illuminate the renal pelvis and ureter. A saline infusion into a percutaneous nephrostomy tube or distention of the bladder can expand the transplant ureter [19]. When identifying the ureter, one must take care to avoid proximal dissection into the renovascular structures and not confuse the ureter with the vas deferens, native ureter, or medial umbilical ligament. In patient 1, ICG was injected intravenously to verify the ureter. In patient 3, ICG was injected through the nephrostomy tube and fluorescence outlined the completely obstructed ureter. Intraoperative ultrasound is an additional modality that can assist with identification of the renal vascular or collecting system structures.

Important surgical considerations during creation of the ureteral anastomosis include ensuring adequate vascular supply, making the anastomosis tension-free, ensur-

ing direct mucosal apposition, confirming that it is leak-proof and properly stented, and using absorbable suture [18].

Of our 3 patients, 2 had postoperative complications. Patient 2 had a Clavien grade II complication of rectus muscle hematoma due to anticoagulation, and patient 3 had a Clavien grade II complication of urinary tract infection [20]. A comparison of RA-TUR to open revisions found that patients whose surgery was done with robotic assistance had lower post-operative length of stay, quicker return to normal food intake, and better control of pain without opiates[11]. Thus, robotic assistance may reduce postoperative convalescence.

Conclusion:

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Transplant ureteral stricture is a complex problem in kidney transplantation patients. In these cases, problem solving involved a multidisciplinary team, endourological diagnosis and intervention, surgical planning, operative intervention, and minimization of perioperative complications. Our case series is limited in size but adds to the literature supporting RATUR as a technically feasible choice to facilitate complex transplant ureteral surgery which can bridge the gap between repeated endourologic procedures and definitive open surgery.

Figure 1: Patient 1: The proximal J of the ureteral stent is visible in the pelvis of the kidney. The midportion of the stent is visible medial to the kidney as it passes through the ureteral stricture and into the bladder.

Figure 2: Patient 2: Stent (Bright mark) exiting extrarenal pelvis at site of stricture.

Figure 3: Patient 3: CT shows a proximally dilated ureter (thin arrow) and a stone (thick arrow) at the distal end of the ureter adjacent to the bladder.

Supplementary Figure 1: Patient Care Timeline

REFERENCES

1. Alberts, V.P., et al., *Ureterovesical anastomotic techniques for kidney transplantation: a systematic review and meta-analysis*. Transplant International, 2014. **27**(6): p. 593-605.
2. YS., C., et al., *Ureteral Complications in Kidney Transplantation: Analysis and Management of 853 Consecutive Laparoscopic Living-Donor Nephrectomies in a Single Center*. Transplantation Proceedings. **48**(8): p. 2684-2688.
3. B., J., et al., *Endourological management is better in early-onset ureteral stenosis in kidney transplantation*. Transplantation Proceedings, 2005. **37**(9): p. 3825-7.
4. Menon, M., et al., *Robotic Kidney Transplantation with Regional Hypothermia: A Step-by-step Description of the Vattikuti Urology Institute-Medanta Technique (IDEAL Phase 2a)*. European Urology, 2014. **65**(5): p. 991-1000.
5. Howie, A.J., L.J. Buist, and M.G. Coulthard, *Reflux nephropathy in transplants*. Pediatr Nephrol, 2002. **17**(7): p. 485-90.
6. Fallah MM, A.A., Estifayi K, Ghafari A, Sepehrvand N, Hatami S, *Frequency of Occurrence of Vesico-Ureteral Reflux in Kidney Transplanted Patients with the New Technique of Uretero Neo Cystostomy*. Saudi Journal of Kidney Diseases and Transplantation, 2010. **21**(2): p. 232-236.
7. Jaffe RB, M.A.J., *Whitaker test: differentiation of obstructive from nonobstructive uropathy*. Am J Roentgenol. **134**(1): p. 9-15.
8. Arpali E, A.-Q.T., Martinez E, et al., *Impact of ureteral stricture and treatment choice on long-term graft survival in kidney transplantation*. Am J Transplant, 2018. **18**(8): p. 1977-1985.
9. Kwong, J., et al., *Optimal management of distal ureteric strictures following renal transplantation: a systematic review*. Transpl Int, 2016. **29**(5): p. 579-88.
10. Simsek, C.D., S M; Piskin, T; Okut, G; Cayhan, K; Aykas, A; Tatar, E; Uslu, A., *Should Interventional Radiology or Open Surgery Be the First Choice for the Management of Ureteric Stenosis After Transplantation? Dual-Center Study*. Transplantation Proceedings., 2017. **49**(3): p. 517-522.

11. Benamran, D.A., et al., *Post-kidney Transplant Robot-assisted Laparoscopic Ureteral (Donor-receiver) Anastomosis for Kidney Graft Reflux or Stricture Disease*. Urology, 2017. **108**: p. 96-101.
12. Yang, K.K., A. Moinzadeh, and A. Sorcini, *Minimally-Invasive Ureteral Reconstruction for Ureteral Complications of Kidney Transplants*. Urology, 2019. **126**: p. 227-231.
13. Sheth, K.R., et al., *Comparing treatment modalities for transplant kidney vesicoureteral reflux in the pediatric population*. J Pediatr Urol, 2018. **14**(6): p. 554 e1-554 e6.
14. Kayler, L., et al., *Kidney transplant ureteroneocystostomy techniques and complications: review of the literature*. Transplant Proc, 2010. **42**(5): p. 1413-20.
15. Lee, S., et al., *Presence of vesicoureteral reflux in the graft kidney does not adversely affect long-term graft outcome in kidney transplant recipients*. Transplant Proc, 2013. **45**(8): p. 2984-7.
16. Molenaar, N.M., et al., *Vesicoureteral Reflux in Kidney Transplantation*. Prog Transplant, 2017. **27**(2): p. 196-199.
17. Vianello, A., et al., *Vesicoureteral reflux after kidney transplantation: clinical significance in the medium to long-term*. Clin Nephrol, 1997. **47**(6): p. 356-61.
18. Vasudevan, V.P., et al., *Contemporary management of ureteral strictures*. Journal of Clinical Urology, 2019. **12**(1): p. 20-31.
19. Pathak, R.A. and A.K. Hemal, *Intraoperative ICG-fluorescence imaging for robotic-assisted urologic surgery: current status and review of literature*. Int Urol Nephrol, 2019. **51**(5): p. 765-771.
20. Dindo D, D.N., Clavien PA. , *Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey*. Ann Surg. **240**(2): p. 205-213.

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| Patient | 1 | 2 | 3 |
|--------------------------------------|--------|--------------------|-------------------------|
| Age | 65 | 45 | 65 |
| Race | W | ME | B |
| Gender | F | M | M |
| Cause of ESRD | DM | IgA nephropathy | MPGN |
| Dialysis (months) | PD x 7 | PD x 3 | HD x 36 |
| Body Mass Index | 25 | 25 | 30 |
| CIT (minutes) | 160 | 109 | 66 |
| WIT (minutes) | 53 | 41 | 59 |
| Post-op RAKT Cr (mg/dL) | 0.8 | 0.98 | 1.4 |
| Duration from RAKT to RATUR (months) | 11 | 19 | 13 |
| LOS after RATUR (days) | 1 | 12 | 14 |
| Catheterization (days) | 10 | 1 | 7 |
| Stent (days) | 43 | 49 | 22 |
| Post-operative complications | None | Port-site hematoma | Urinary Tract Infection |
| Total Operative Time | 171 | 223 | 122 |

Demographic Information and RAKT Details

Race: W=white, ME=middle eastern, B=Black

F=female, M=male

ESRD = end stage renal disease

DM=diabetes mellitus, MPGN=membranoproliferative glomerulonephritis

PD=peritoneal dialysis, HD=hemodialysis

CIT=cold ischemic time, WIT=warm ischemic time

RAKT= robotic assisted kidney transplant, Cr=creatinine

Figure 1



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Figure 2



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Figure 3



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