Ex-vivo ureteroscopy of deceased donor kidneys

Graham L. Machen, MD; Preston A. Milburn, MD; Patrick S. Lowry, MD; Jacqueline A. Lappin, MD; Debra K. Doherty, MD; Marawan M. El Tayeb, MD

Department of Surgery, Divisions of Urology and Transplant, Baylor Scott & White Health/Texas A&M Health Science Centre College of Medicine, Temple, TX, United States

Cite as: *Can Urol Assoc J* 2017;11(8):251-3. http://dx.doi.org/10.5489/cuaj.4327

See related commentary on page 254.

Abstract

Introduction: When encountered, the ideal management of lithiasis in deceased donor kidneys is not well-defined. With advances in endourological techniques, minimally invasive treatments are becoming an increasingly viable option. We set out to describe our experience performing ex-vivo ureteroscopy on cadaveric donor kidneys, including one in which the procedure was completed on-pump.
Methods: A retrospective chart review was undertaken to identify patients who had undergone ex-vivo ureteroscopy prior to cadaveric renal transplant. Four patients were identified, including one in which the procedure was done with the kidney remaining on-pump. The surgical technique and subsequent data were reviewed.
Results: Ex-vivo ureteroscopy was successfully completed in all four instances without intraoperative complication. All kidneys were endoscopically stone-free. Creatinine nadirs ranged from 0.8–1.4. All four patients remained stone-free at a mean followup of 13 months.
Conclusions: Our series provides further evidence as to the safety and efficacy of ex-vivo ureteroscopy prior to transplantation in cadaveric renal transplants and describes a novel technique in the form of on-pump ex-vivo ureteroscopy.

Introduction

In the management of end-stage renal disease, transplantation remains the best long-term treatment option. As of June 2016, there were more than 99 000 individuals on the wait list for a renal transplant in the U.S. In 2015, 23 176 deceased donor and 5898 living donor transplantations took place.[1] This relative shortage of organs has led to many transplant centres reviewing donor exclusion criteria. One such criterion is the presence of stones in potential allograft kidneys. Previously, this was felt to be at least a relative contraindication to organ donation.[2] Partly due to the advancement of endourological techniques in the past 20 years, these restrictions have become more relaxed; however, the ideal management of allograft urolithiasis is not well-established. Minimally invasive treatment of urolithiasis prior to transplant seems to be an increasingly used method of rendering allografts stone-free prior to transplant.

Here within, we describe our experience in management of urolithiasis in cadaveric renal transplants. Four patients were the recipients of cadaveric renal transplants who were found to have non-obstructing renal stones on preoperative computed tomography (CT) scans. All of these kidneys underwent ex-vivo ureteroscopy (ExURS) to address these stones, including one kidney that remained on-pump for the duration of the procedure. We report our experience, including operative technique and followup data.

Methods

After institutional review board approval was obtained, a retrospective study was undertaken to identify patients who had received cadaveric kidneys that underwent ExURS on the back table prior to transplant. Ultimately, four patients who had received kidneys from two cadaveric donors were found. In each instance, the donor died of anoxia with a terminal creatinine of approximately 0.9. Both patients had a known history of nephrolithiasis, and bilateral non-obstructing stones were diagnosed on pre-transplant CT scan. Table 1 shows further donor characteristics. Imaging was unavailable from one donor; in the other, there was a 7 mm lower pole and a 4 mm interpolar calyx stone on the right. On the left, there were two stones in the upper pole measuring 2 and 3 mm, and a 4 mm stone in an interpolar calyx (Fig. 1).

Ex-vivo ureteroscopy technique

Three of the cadaveric kidneys were immediately transferred to an ice bath. The ureters were spatulated, and a Storz Flex-X ureteroscope was carefully inserted under direct vision and manual irrigation of normal saline without use of a wire, nor

Table 1. Characteristic of cadaveric donors		
	Donor 1	Donor 2
Age/gender	42 M	29 F
Cause of death	Anoxia	Anoxia
KDPI	25%	21%
Terminal creatinine	0.9	0.87
History of stones?	Yes	Yes
Normal anatomy?	Yes	Yes
Urinalysis	No evidence of infection	No evidence of infection

KDPI: Kidney Donor Risk Index.

access sheath. The stones were localized under direct vision and were fragmented using holmium laser lithotripsy. The fragments were removed with a basket. Upon completion, each kidney was endoscopically stone-free. Transplantation was then completed by the transplant team.

Ex-vivo ureteroscopy while on pump

With the latch enclosing the kidney lifted, the renal artery and vein cannulas were briefly removed to identify the ureter. Once identified, the cannulas were replaced and perfusion was maintained for the duration of the procedure. The kidney was held by the pump in an anatomical position for the duration of the case. An infundibular stenosis was incised using the holmium laser to reach a small stone fragment; otherwise, the operation proceeded as described above.

Results

All ExURS were completed without complication in allografts. Operative time for each case was approximately 30 minutes. The mean age of the recipients was 38.5 years (range 27–51). Creatinine at discharge was 2.94 (range 1.59–5.45). The individual in which an infundibular stenosis was incised had mild hematuria postoperatively, which resolved on its own after several days. Polaris ureteral stents measuring 5 Fr x 10 cm were left in all four recipients for an average of 30 days (range 18–41). See Table 2 for a summary of patient data. Stone analyses were performed on three of the four patients. All three stones were predominantly calcium oxalate monohydrate, with two being 100%, and the last 75% calcium oxalate monohydrate and 25% calcium apatite.

The kidneys were monitored with serial ultrasounds and at a mean of 13.5 months (range 8–19) there was no radiographical evidence of recurrence or urological complication. Metabolic stone workups were completed on three of the four recipients, as shown in Table 3. One individual was found to have hypercalciuria, elevated pH, and low urine volume. Another had hypocitraturia, low urine volume, and elevated urine pH, while the last had only hypocitraturia. No treatments were initiated as a result of these findings since the patients did not form any further stones.

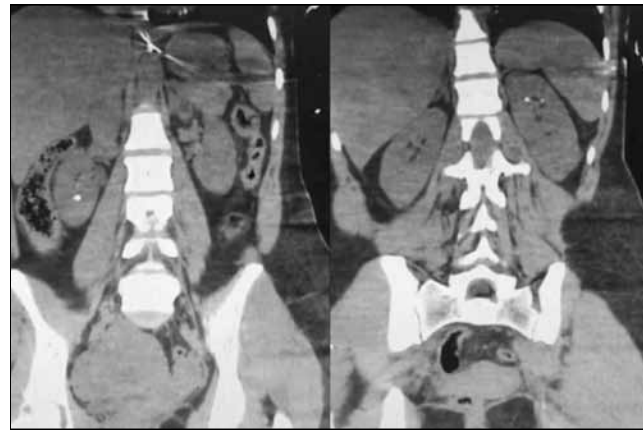

Fig. 1. Two stones in the upper pole measuring 2 and 3 mm (left), and a 4 mm stone in an interpolar calyx (right).

Discussion

As previously mentioned, urinary lithiasis had previously been considered a relative contraindication to renal transplantation, primarily due to concerns over stone formation in the recipient, and the donor in cases of live donor transplantation. In 1996, Kasiske et al determined in their clinical practice guidelines regarding living renal transplant donors that nephrolithiasis was a relative contraindication to donation due to risk of recurrent stone formation. They further recommended that all patients with a history of nephrolithiasis undergo a metabolic workup and, pending a normal result, would be allowed to donate only if the patient had passed one stone previously, no stones identified on imaging, and had inactive stone disease for the past 10 years.[2]

These guidelines were relaxed somewhat in 2005 by Davis and Delmonico, who determined that an individual with a single stone could donate if they were not at a high risk of recurrence, the stone was less than 15 mm, and if the

Table 2. Summary of patient data									
#	Sex	Age	Ureteroscope used	Laser used?	Stent size	Duration of stent (days)	Creatinine at discharge	Creatinine nadir	Duration of followup (months)
1	F	34	Flexible	Yes	5 Fr x 10 cm	20	1.59	0.8	8
2	F	42	Flexible	Yes	5 Fr x 10 cm	18	5.45	1.41	8
3	M	27	Flexible	Yes	5 Fr x 10 cm	41	2.1	1.02	18
4	M	51	flexible	yes	5 Fr x 10 cm	41	2.6	1.02	18

Table 3. Urorisk diagnostic profile results

	Recipient 1	Recipient 2	Recipient 3
Urine calcium	383	53	27
Urine oxalate	39	21	16
Urine uric acid	363	416	218
Urine citrate	519	95	81
pH	7.3	5.7	7.2
Total volume	1.79	3.41	1.22
Urine sodium	153	162	98
Urine phosphorus	576	641	300
Urine magnesium	76	51	21
Urine potassium	38	41	10
Urine creatinine	946	1040	789
Urine sulfate	3	14	6
Sodium urate supersaturation	1.56	0.38	1.32
Calcium oxalate supersaturation	3.81	0.23	0.47
Brushite	7.07	0.07	0.70
Uric acid	0.05	0.88	0.06

stone was potentially removable during transplant. They further recommended a metabolic workup of potential donors with a history of a single stone.[3,4] Around that time, the Amsterdam Forum on the Care of the Live Kidney Donor was issued. The Forum further expounded on metabolic criteria for declining potential donors, including no hypercalciuria, hyperuricemia, metabolic acidosis, cystinuria, hyperoxaluria, or presence of multiple stones

ExURS has been shown to be a safe and effective means of rendering an allograft kidney stone-free in several other case series. In 2002, Kingler et al describe the use of a cystoscope through a pyelotomy on the back table to remove stones,[5] but it appears the first series of true ExURS was published by Rashid et al in 2004, in which they detail the successful ExURS of 10 living donor kidneys at the time of transplant.[6] Olsburgh et al published the largest series of ExURS in 2013, consisting of 17 living donor kidneys. One operation failed due to inability to insert the ureteroscope; the procedure was successful in the remaining patients.[7]

To our knowledge, ExURS with the cadaveric kidney on-pump has not been previously described. This easily reproducible technique was felt to confer several advantages. First, while ExURS is typically able to be completed in a timely fashion, perfusion of the kidney is able to continue and the time off pump is minimized. Second, the pump served to anchor the kidney for ureteroscopy and maintain an anatomical position. Third, as ExURS is traditionally done in an ice bath with the surgeon's hand holding and manipulating the kidney, the pump obviates the need to submerge one's hand in the ice bath, which can be intolerable.

One concern in these individuals is obviously the recurrence of nephrolithiasis. Previous studies have demonstrated a multifactorial cause of stone formation in transplant patients. Further, transplant kidney stone formers seem to be associated with greater water excretion and more concentrated and alkaline urine.[8] Additionally, cyclosporine is known to result in hyperuricosuria in 50–60% of patients using this medication for immunosuppression, although the incidence of uric acid stones remains low.[9] Despite these risk factors, the reported incidence of stones in transplant kidneys remains low, with published rates of 0.2–1.7%.[5]

In our series, none of the recipients had any evidence of recurrence, albeit at a limited duration of followup. Further, an additional limitation of the study is the small sample size, consisting of only four total patients, and just one who underwent the novel, on-pump approach.

Conclusion

Our series provides further evidence as to the safety and efficacy of ExURS, as well as provides details of a novel approach in the form of on-pump ex-vivo ureteroscopy.

Competing interests: The authors report no competing personal or financial interests.

This paper has been peer-reviewed.

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Correspondence: Dr. Graham L. Machen, Department of Surgery, Divisions of Urology and Transplant, Baylor Scott & White Health/Texas A&M Health Science Center College of Medicine, Temple, TX, United States; graham.machen@bswhealth.org