TRANSPLANT INTERNATIONAL

Transplant International ISSN 0934-0874

ORIGINAL ARTICLE

Ureteric reconstruction for the management of transplant ureteric stricture: a decade of experience from a single centre

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Keywords
Boari flap, kidney transplant, reconstruction, ureteric stricture.

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Conflicts of interest
The authors have declared no conflicts of interest.

Received: 8 October 2014
Revision requested: 26 November 2014
Accepted: 29 December 2014
Published online: 16 February 2015

doi:10.1111/tri.12508

Summary

This study was conducted to review the outcomes of patients who had undergone surgical repair of a ureteric stricture following renal transplantation. All patients who developed a ureteric stricture and underwent ureteric reconstruction following renal transplantation, between December 2003 and November 2013, were reviewed. One thousand five hundred and sixty renal transplants were performed during the study period. Forty patients required surgical repair of a ureteric stricture (2.5%, 25 male, median age 48 [14–78]). The median time to stricture was 3 [1–149] months. 19 patients were reconstructed by reimplantation to the bladder, 18 utilized a Boari flap, two were a pre-existing ileal conduit and one was an anastomosis to a native ureter. In one patient, reconstruction was impossible and consequently an extra-anatomic stent was used. Two patients required re-operation for restricture and kinking. Median serum creatinine at 12 months following surgery was 148 [84–508] μmol/l. There was no 90-day mortality. Eleven grafts were lost at the time of this study, a median time of 11 [1–103] months after reconstruction. The incidence of ureteric stricture following renal transplant is low. Surgical reconstruction of the transplant ureter is the optimal treatment and is successful in the majority of patients.

Introduction

Major ureteric complications following renal transplantation are a significant source of morbidity, compromised graft function and can cause mortality [1–3]. Ureteric stricture remains the most common major ureteric complication [2], with a varying incidence reported in the literature of between 0.6% [4] and 12.5% [5] of all renal transplant recipients. The majority of complications occur within 3 months of transplantation and affect the distal part of the ureter [5–8]. Ureteric strictures are thought to result from inadequate preparation of the transplant ureter, ischaemia of the distal ureter, technical issues during implantation, episodes of rejection, infection (BK virus nephropathy) or a fluid collection surrounding the ureter causing external compression [4,5,7,8]. In the absence of technical issues, ureteric ischaemia is believed to be primarily responsible [9]. This is because the sole arterial supply to the transplant ureter is derived from the main renal artery or its lower polar branch. These vessels descend from the hilum and are carried in the adventitia surrounding the ureter. They can be damaged during organ recovery and overenthusiastic back bench dissection causing excessive stretch or skeletonization of the ureter [10,11]. Regrettably, which ureter will subsequently develop a complication is not always apparent intra-operatively [12]. The majority of significant ureteric complications will require interventional management, either via percutaneous or endoscopic stenting, by surgical revision, or more often a combined, stepwise approach [4,5,7,8]. Despite the increasing use of minimally invasive management of such complications [13,14], surgery remains the only definitive long-term option for managing ureteric strictures [2].

This study was conducted to review the outcomes of patients who had undergone surgical repair of a ureteric stricture following renal transplantation, over a 10-year period, at a single institution.

Patients and methods

All patients who developed a ureteric stricture following renal transplantation and subsequently underwent surgical ureteric reconstruction between December 2003 and November 2013 were included in the study. During this period, organ recovery and implantation techniques were relatively uniform. There was a lack of homogeneity with immunosuppression regimes due to our centre's participation in clinical trials [15,16]. Our institution started utilizing renal grafts from donors following circulatory death (DCD) in 2002, and we have seen an exponential increase in the utilization of such grafts in subsequent years. These now represent one-third of all renal transplants that are performed in our institution.

Patients were identified from a prospectively maintained database of ureteric complications and interventions. Patients' preoperative morbidities, previous interventions and postoperative outcomes were retrospectively analysed from both paper-based and electronic patient records. All the ureteric reconstructions were carried out in a single institution, making the data relatively accurate and reliable. Statistical analysis was performed using PRISM version 6.0c (GraphPad Software, La Jolla, CA, USA). The Mann–Whitney *U*-test and chi-square test were used to compare continuous and categorical data, respectively; a P value of <0.05 was considered statistically significant.

Technique of renal transplant and ureteroneocystostomy

The standard technique of renal transplant at our institution included an extraperitoneal approach through an iliac fossa incision and vascular anastomoses to external iliac vein and artery. An extravesical technique of ureteric implantation was routinely used for ureteroneocystostomy. All ureteric implantations utilized an onlay technique with full thickness 'all-layer' anastomosis and a double-J pigtail stent used to bridge the anastomosis to the bladder. This stent was routinely removed after 6 weeks under local anaesthetic.

Technique of ureteric reconstruction

Surgical ureteric reconstruction utilized an extraperitoneal approach in all cases. The initial incision was through the existing transplant scar. The retroperitoneal space was entered and the transplant kidney identified. The transplant ureter was often difficult to identify. The presence of a ureteric stent, as well as the relationship of the spermatic cord, external iliac vessels and lower pole of the kidney aided identification. Prior knowledge of the laterality of the donor kidney was helpful in operative planning. The strictured section of the ureter was further identified and excised. An assessment was then made regarding the optimal method of reconstruction:

1. If the proximal nonstrictured healthy ureter could reach the bladder, a simple re-implantation technique was used over a double-J stent. This occasionally required mobilization of the urinary bladder and hitching stitches to psoas and adjacent adventitia to avoid tension on the anastomosis.
2. If the ureter did not reach the bladder without tension, then a Boari flap reconstruction [17] was undertaken whenever possible, Fig. 1.
3. When neither re-implantation of the transplant ureter or Boari flap was feasible, anastomosis to the native ureter was performed. This was not the preferred technique as dissection of the native ureter is often difficult in the presence of a transplant kidney, and their integrity is often not known or investigated.

All reconstruction techniques employed the use of a double-J stent, which was removed after 6 weeks.

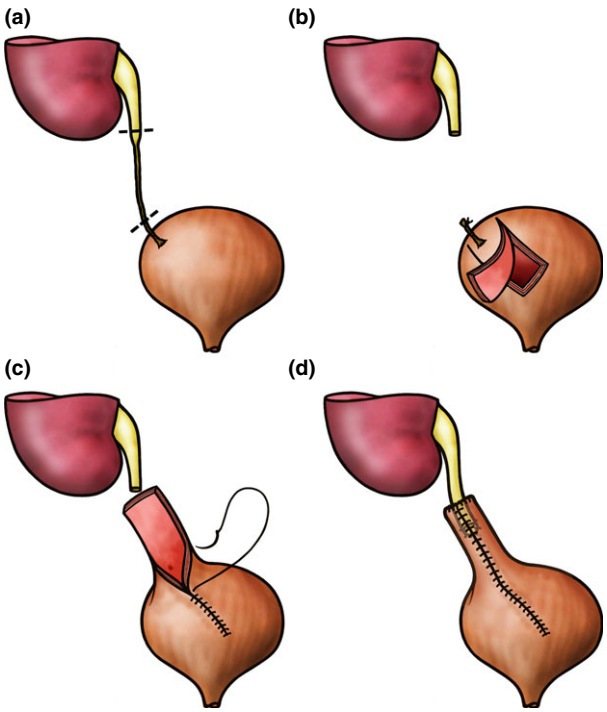

Figure 1 Technique of reconstruction of transplant ureteric stricture utilizing a Boari flap. (a) Long segment distal ureteric stricture. (b) Excision of stricture & bladder flap to construct Boari flap. (c) Completion of Boari flap. (d) Ureteric anastomosis to the Boari flap. Illustrations by Paul Brown.

Results

One thousand five hundred and sixty renal transplants were performed at our centre during the study period. 56 patients developed a ureteric stricture that required intervention, giving an overall incidence of 3.6%. Sixteen of these patients were managed with radiologically placed stents alone. We performed operative ureteric reconstruction on 42 patients. Two of these reconstructions were performed at the time of transplant implantation for high ureteric injury sustained during recovery of organs. The remaining 40 patients required surgical reconstruction for ureteric stricture (2.5% of all transplant recipients) following transplantation.

Twenty-five male and fifteen female transplant recipients required surgical ureteric reconstruction, with a median age of 48 [range 14–78]. Of these, 18 (45%) received a donation after brainstem death (DBD), 12 (30%) received DCD (including one dual transplant), and 10 (25%) received a living donor (LD) graft. Five were retransplant grafts (second or third). The median cold and warm ischaemic times were 14:38 h [range 32 m–24:30 h] and 33 min [range 20–42 m], respectively. Seven kidneys had multiple arteries, three with a lower polar artery that was anastomosed.

The median time to stricture was 3 months [range 1 month–12 years] from transplant, Fig. 2. There was no significant difference in the time to stricture between DCD, DBD and LD grafts. Three patients experienced at least one episode of rejection following transplantation. There was, however, no temporal relationship of acute rejection and development of ureteric stricture. Three (33%) of the patients who developed very late strictures (defined as a stricture occurring more than one thousand days after transplant implantation) also had BK virus infection (n = 1) and/or interstitial fibrosis and tubular atrophy (IF/TA, $n = 3$).

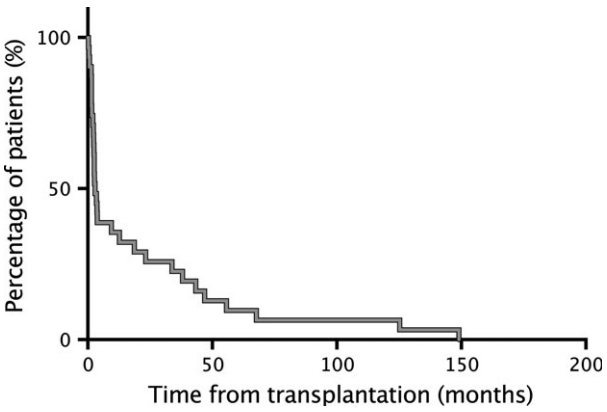

Figure 2 Time from transplantation to stricturing of ureter.

All patients underwent nephrostomy insertion or antegrade stenting prior to surgical repair. Nineteen patients were reconstructed by reimplantation of the ureter to the bladder, 18 utilized a Boari flap, two used a pre-existing ileal conduit and one an anastomosis to the native ureter. The latter was performed in a case of ureteric stricture to the upper transplant kidney of a dual transplant. The native ureter was ligated below the pelvis and distal ureter swung laterally to anastomose to the lower pole calyx of the transplant kidney. All reconstructed anastomoses were stented. In one patient, surgical reconstruction was deemed impossible and they were consequently managed with an extra-anatomic stent (EAS). Two patients (5%) subsequently required a further operation for restricture and kinking of the ureter, respectively, Table 1.

Median serum creatinine at 12 months following surgery was 148 μmol/l [range 84–508 μmol/l]. There was no 90-day mortality. 11 grafts (27.5% of patients who had undergone a ureteric reconstruction) were lost at the time of this study with a median duration of 11 months [range 1 month–8.6 years] after reconstruction. The majority of graft losses were due to either IF/TA, the damage already caused by obstructive uropathy, or a combination of these, Fig. 3.

Discussion

The incidence of ureteric stricture following renal transplantation in our institution is low (3.6%). Ureteric stricture typically occurred within 3 months after transplantation with some late strictures developing after this period. There was no significant association between the age or gender of the recipient, age or gender of the donor, type of donation (DBD, DCD and LD), cold and warm ischaemia time, number of renal arteries or the presence of a lower polar artery, immunosuppression used or episodes of acute rejection. Late strictures, several years

Table 1. Summary of results for transplant ureters that developed stricture ($n = 56$).

Median recipient age	48 [14–78]
Median donor age	51 [18–71]
DBD/DCD/LD	DBD 45%, DCD 30%, LD 25%
Median CIT	14:38 h [32 m–24:30 h]
Median WIT	33 min [20–42 m]
Median time to stricture	3 months [1 month–12 years]
Management	40 reconstruction 16 managed by stent changes
Reconstruction Technique	19 re-implantation of ureter 18 Boari flap 2 ileal conduit 1 anastomosis to native ureter

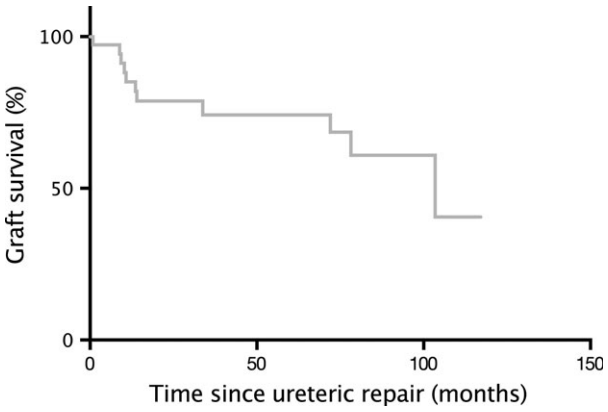

Figure 3 Graft survival following ureteric repair.

after transplant, were associated with IF/TA or BK virus nephropathy.

The average number of arteries was 1.175 in the patients who developed a ureteric stricture. This number is less than what has been reported in other studies, which report a higher number of arteries in patients who developed a ureteric stricture [18,19].

Surgical reconstruction of the transplant ureter was considered and offered to all patients in our study, whenever feasible. All patients presenting with graft obstruction secondary to ureteric stricture required initial management by radiological decompression via a nephrostomy and placement of an antegrade stent. In 16 of 56 patients in our series, this management was definitive and these patients were managed by regular stent change. This management route was adopted because of either a poor graft function despite decompression or the patients were not fit for a general anaesthetic. In one case, the reconstruction was abandoned as it was considered technically high risk. This patient was subsequently managed by utilizing an extra-anatomic stent. In cases of short-segment distal ureteric stricture, endoscopic management with balloon dilatation has been successfully employed [14]. However, such management is associated with an increased risk of recurrent stricture requiring repeated treatment.

The surgical management of ureteric stricture includes: (i) simple reimplantation on to the bladder after excising the strictured segment – this is usually the treatment of choice in cases of short-segment distal stricture, (ii) reimplantation of the proximal ureter on to a Boari flap – this is particularly useful in cases of long segment often ischaemic ureteric stricture, (iii) anastomosis to the native ureter and (iv) a reconstructing ileal conduit between the proximal ureter and the bladder. Surgical reconstruction by simple excision and reimplantation or re-implantation on to a Boari flap is successful in the majority of the patients with a low risk of recurrence. We favour reimplantation of the transplant ureter as our standard technique, with Boari flap reserved for cases of long-segment ureteric stricture. Anastomosis to native ureter has been favoured by some authors [20]. We feel that the dissection of the native ureter is often difficult due to the presence of the transplant kidney. In addition, the native ureter has often been redundant for several years and has not been thoroughly evaluated before undertaking reconstruction. Nevertheless, a normally draining ureter is a useful adjunct for reconstruction. The proximal transplant ureter can be anastomosed end-to-side to the native ureter. Alternatively, the native ureter may be ligated proximally with distal ureter swung to perform end-to-end anastomosis to the transplant ureter. Ligation of the native ureter in most cases is nonconsequential with atrophy of the native kidney in the long term [21–23]. The authors suggest that the technique of uretro-

Table 2. Surgical management of transplant ureteric obstruction, a review of published literature.

Country	Author	Duration of study	No. of transplants	No. of stricture	Technique of repair	Graft survival
Germany	Doehn *et al.*	1997–2005	636	25 (3.93%)	21 Politano-Leadbetter 4 Lich-Gregorie	60% at 5 years
France	Karam *et al.*	Jan 1990–Dec 2002	1787	74 (4.1%)	Open neo-uretocystoscopy*	63% at 10 years
Germany	Keller *et al.*	Jan 1976–Dec 1992	1298	40 (3.1%)	32 ureteric reimplantation 6 pyelocystostomy 2 ureteroureterostomy	62.5% at 1-16 years
UK	Mundy *et al.*	May 1967–Dec 1979	1000	52 (5.2%)	46 ureteric reimplantation 6 ureteroneocystostomy or pyelocystostomy 1 ureteric meatotomy	62.5%
UK	Pike *et al.*	Dec 2003–Nov 2013	1560	40 (2.5%)	19 re-implantation 18 Boari flap 2 ileal conduit 1 anastomosis to native ureter	72.5% at 1–10 years

*During the last 5 years of this study, 'percutaneous and endoscopic techniques were used every time they were feasible.'

uretrostomy should be reserved for cases where a simple re-implantation or a Boari flap reconstruction is not possible.

In one case, we utilized the native ureter for reconstruction. This was a case following a dual kidney transplant. An ipsilateral 'double-decker' technique had been used for the original transplant, with separate ureteric anastomoses on to the bladder. There was a long-segment stricture of the entire ureter of the upper kidney. Surgical access to the urinary bladder was restricted because of the presence of the second renal transplant, and it was impossible to utilize a Boari flap, due to the insertion of the second transplant ureter. In this instance, we recruited the native ureter from a nonfunctioning native kidney. The native ureter was ligated below the pelvis and the distal ureter swung laterally to anastomose to the lower pole calyx (the proximal ureter or the renal pelvis was not accessible) of the transplant kidney, with a good outcome.

In a small number of cases where surgical reconstruction is not possible and ureteric stenting unsuccessful, an extra-anatomic detour stent may be used. This technique, whilst rarely used for transplant ureteric strictures, provides a useful adjunct to managing difficult transplant ureteric strictures. We successfully managed one of our patients with an extra-anatomic detour stent. Attempts at radiological and endoscopic stenting were unsuccessful. Surgical reconstruction was attempted, but was abandoned due to difficult anatomy. During the postoperative period, this patient developed acute coronary syndrome, and consequently, further surgical management was deemed to carry an unacceptably high risk. An extra-anatomic detour stent provided a successful management. The procedure can be performed by a combined percutaneous and endoscopic approach under general anaesthetic. The stent can be changed under local anaesthetic as a day case procedure. We recommend this technique to be used in cases where conventional surgical and nonsurgical approach has been unsuccessful [24], a finding that has been replicated in other centres [25,26].

Three patients in our study had the diagnosis of IF/TA and/or BKV nephropathy concurrent to the diagnosis of ureteric stricture. All of these patients subsequently underwent surgical repair of ureteric stricture.

A review of literature pertaining to surgical repair of ureteric stricture reveals a paucity of studies with significant patient numbers, but similar results, Table 2.

Our results show that surgical ureteric reconstruction is safe and effective in the management of transplant ureteric stricture. Most reconstructions can be performed with either simple re-implantation or utilization of a Boari flap with anastomosis to the native ureter reserved for difficult cases. Where surgical reconstruction is not feasible (due to poor graft function or the patient being unfit for surgery), these strictures may be managed by regular change of a ureteric stent. An extra-anatomic stent may provide an alternative in cases where conventional measures have been unsuccessful.

Authorship

NA: conceptualized the study, maintained the departmental database and acquired missing data from NHSBT. TWP and THJ: collected additional data from local computer systems and cross-checked the radiology records of each transplant recipient who had undergone an intervention for ureteric complications. TWP: wrote the manuscript and revised it, incorporating suggestions made by the other authors. SP: checked the accuracy of the data and revised the initial manuscript. NA and LH: revised the manuscript. NA reviewed and approved the final manuscript and will be the corresponding author.

Funding

None.

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