Urothelial-based reconstructive surgery for upper- and mid-ureteral defects: Long-term results

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Abstract

Introduction: Ureteral strictures can result in obstructive nephropathy and renal function deterioration. Surgical management of ureteral defects, especially in the proximal- and mid-ureter, is particularly challenging. Our purpose was to analyze the long-term outcomes of urothelial-based reconstructive surgery for upper- and mid-ureteral defects.

Methods: We conducted a retrospective analysis of a single tertiary centre's database, including 149 patients treated for ureteral defects between 2001 and 2011. Thirty-one patients (21%) underwent complex urothelial-based surgical repairs for upper- and mid-ureter defects. Patients' median age was 61 years. The mean length of the ureteral strictures was 2.5 cm, located in upper-, mid-ureter, or in between in 19 (61%), 10 (32%), and two (6%) patients, respectively. All patients were treated with a primary urothelial-based repair. Median followup time was 26 months. The primary outcome of the study was the long-term preservation of renal function and lack of clinical obstruction. The secondary endpoint of the study was the assessment of the intra- and postoperative complication rates.

Results: Most of the lesions were benign (22, 71%), while nine strictures (29%) were malignant. Seven patients (23%) suffered from postoperative complications, five of which were infectious. The median pre- and postoperative calculated glomerular filtration rates were 66 ml/min/1.72m^2 and 64ml/min/1.72m^2, respectively. Success rate was 84%, defined as lack of need for re-operation or kidney drainage at the last followup.

Conclusions: Upper- and mid-ureteral defects present a complex pathology necessitating experienced reconstructive surgical skills. Our data suggest good long-term results for primary urothelial-based reconstructions for these pathologies.

Introduction

Ureteral stricture can result from either benign or malignant pathologies. Common etiologies include ureteral calculi, surgical and non-surgical trauma, periureteral fibrosis, and malignancy.[1] Reconstruction of the distal ureter is relatively easy due to its proximity to the bladder, which allows the use of ureteroneocystostomy as a definitive therapy.[2] However, reconstruction of the mid- and upper-ureter, especially with long-length ureteral defects or loss, is particularly challenging. The optional surgical reconstructive approaches for those cases include the use of bowel interposition, buccal graft, autotransplantation, urothelial-based ureteral reconstruction, and rarely, nephrectomy, the latter of which is the only definitive solution.[3-6]

Urothelial-based ureteral reconstruction of the mid- and upper-ureter has several advantages, including avoidance of bowel surgery (i.e., ileal ureter) or vascular surgery (i.e., autotransplantation) and the ability to preserve renal function. On the other hand, it is a complicated procedure and the functional long-term data on large cohorts are limited.

We hereby report a single-institute experience with complex upper- and mid-ureteral pathologies treated by urothelial-based reconstructive surgery.

Methods

We conducted a single-centre, retrospective review of patients treated by ureteral reconstructive surgery from January 2001 to December 2011. We included patients with proximal- and mid-ureteral lesions (defined as located proximally to the distal end of the sacro-iliac joint), excluding bowel interposition. Five surgeons with over 10 years' experience as senior surgeons and over five caseloads for similar reconstruction surgeries each operated on all patients using open or laparoscopic surgical techniques. Specific technique was subject to surgeon's preference per case. In general,

extraperitoneal approach was preferred, with primary anastomosis performed using "fish mouth" ureteral incision and two absorbable, single-arm running sutures over a double J stent (12 o'clock–6 o'clock). Applying tension-free anastomosis was the rule for all cases. The hospital's Institutional Review Board consented to our review.

The primary outcome of our study was long-term success, i.e., preservation of renal function and lack of clinical obstruction. We estimated glomerular filtration rate (eGFR) by the Cockcroft-Gault formula; differences in eGFR were classified as improved, stable, or worsened, using the chronic kidney disease (CKD) stages as defined by Kidney Disease: Improving Global Outcomes (KDIGO).[7] A 30 ml/min/1.72m^2 cutoff was used to determine severe renal failure (CKD Stages 4 or 5). Re-operation or kidney drainage (either percutaneous or internal) due to repeat obstruction was considered failure. The secondary endpoint of the study was the assessment of the intra- and postoperative complication rates using the Clavien-Dindo complication score.[8]

Results

We reviewed a total of 149 ureteral surgeries from January 2001 to December 2011. Reconstructive operations to correct proximal- and mid-ureteral defects were performed in 31 patients (21%). The patients' demographic details and ureteral stricture preoperative data are shown in Table 1. The mean defect length was 2.5 cm (range 0.9–7 cm.). Case X (Fig.1) is a typical example. The reconstructive methods included uretero-ureterostomy anastomosis, Boari flap, uretero-pelvic anastomosis, uretero-calicosotomy, and vesico-pelvic anastomosis of a transplant kidney (Table 2). The median followup period was 26 months (1–142).

Table 1. Patients demographics, pathophysiology of ureteral defect and chronic kidney disease stage (by KDIGO[7]) according to pre-surgical data

Demographic and preoperative data	
Age, median (years)	61
Gender, n (%)	
Male	19 (61)
Female	12 (39)
Preoperative pathology	
Iatrogenic injury	9 (29)
Nephrolithiasis	6 (19)
GU malignancy	6 (19)
Other malignancy	3 (10)
Fibrosis and FMF	2 (6)
Retrocaval ureter	1 (3)
Idiopathic or NA	4 (13)
Side, n (%)	
Right	13 (42)
Left	16 (52)
Transplanted kidney	1 (3)
NA	1 (3)
Defect location	
Upper ureter	19 (61)
Mid-ureter	10 (32)
Mixed	2 (6)
Preoperative CKD stage	
1	5 (16)
2	15 (48)
3	5 (16)
4	4 (13)
NA	2 (6)

CKD: chronic kidney disease; FMF: familial Mediterranean fever; GU: genitourinary; NA: not available.

Renal function

Pre and postoperative eGFR was available for 28 patients. The median pre- and postoperative serum creatinine levels at last followup were 1.07 mg/dL (range 0.68–2.5) and 1.13 mg/dL (range 0.77–2.94), respectively. The median pre- and postoperative eGFR at last followup were 66 ml/min/1.72m^2 (range 27–119) and 64 ml/min/1.72m^2 (range 19–147), respectively (no weight adjustments taken). Kidney function, as defined by CKD stage, was improved in one patient (3%), stable in 21 patients (68%), and worsened in six (19%); pre and postoperative CKD stages were not available for three patients (10%). Among the six patients with worsening CKD stage, five had progressed from Stage 2 to Stage 3 and one from Stage 1 to Stage 2.

Final pathology

The final pathology was benign in 25 patients (81%) and malignant in six (19%). Among the malignant etiologies, four patients (13%) suffered from genito-urinary malignancy (transitional cell carcinoma) and two (6.5%) had non-genitourinary malignancies (leiomyosarcoma and carcinoma of undefined origin).

Surgical outcome

At five years from surgery, the success rate was 84%. Surgical failure occurred in five patients (16%), who were all treated by percutaneous nephrostomy tubes. One of the patients eventually underwent nephrectomy due to a nonfunctioning, infected kidney (Fig. 2). One patient underwent a nephroureterectomy for a recurrent upper tract urothelial cancer without evidence of drainage failure at the time of surgery. The average time to failure from surgery was approximately two

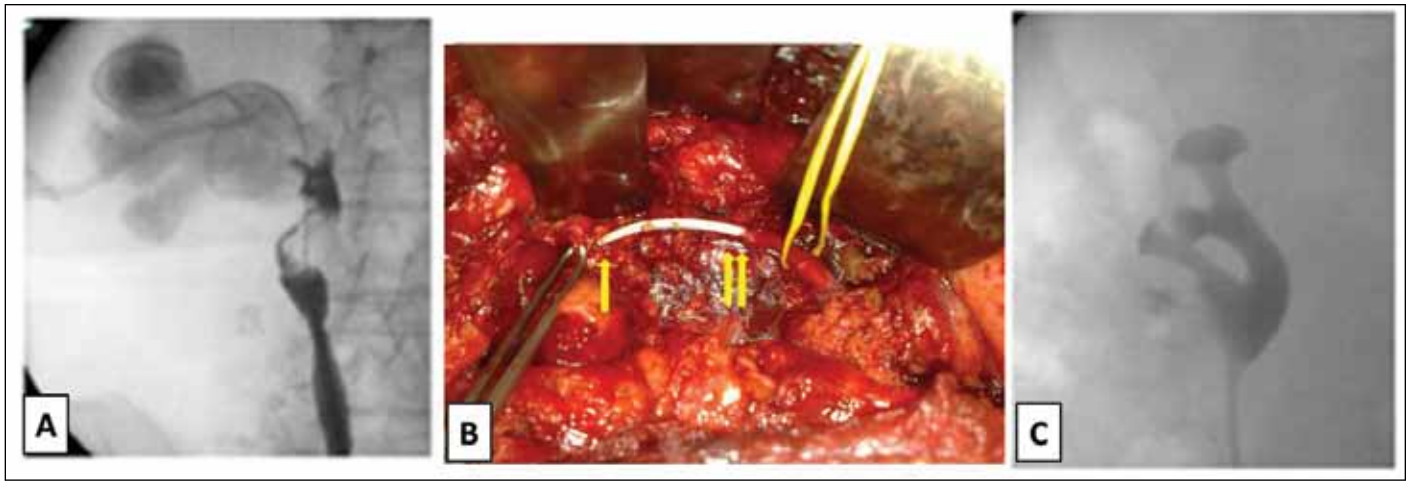

Fig. 1. 2.5 cm upper ureteral stricture. ***(A)*** Preoperative antegrade pyelography; ***(B)*** Stent inserted through the ureteral gap (after resection) renal pelvis marked by arrow, proximal ureter by double arrow; ***(C)*** postoperative retrograde pyelography.

months (range 8–183 days). Subgroup analysis for uretero-ureterostomy surgery (20 patients, 65%) showed a success rate of 90% (18/20 patients).

Our failed patient subgroup included four (80%) benign and one (20%) malignant lesion (upper tract urothelial carcinoma). No correlation was found between the etiology of the lesion (benign or malignant) and the complication or failure rates (Fig. 3).

Complications

Postoperative complications occurred in seven patients (23%). Complications included urinary tract infection in five (16%) and anastomotic leak, uretero-cutaneous fistula, and wound infection in one patient each (one patient suffered both urinary tract infection and anastomotic leak). According to the Clavien-Dindo complication score; two patients had a Grade II, four had Grade IIIa, and one Grade IIIb complications. None of the patients required repeat perioperative surgical exploration and there was no perioperative death.

Table 2. Operative technique*

Operative technique	n (%)
Urothelial-based surgery	
Uretero-ureterostomy (end-to-end)	20† (65)
Boari flap	7 (23)
Uretero-pelvic	2 (6)
Uretero-calicostomy	1 (3)
Vesico-pelvic (transplanted kidney)	1 (3)

*Unless otherwise specified, all procedures were performed using open surgical approach; †17 open, 3 laparoscopic.

Discussion

Surgical reconstruction of the ureter is a challenging procedure, in particular for upper- and mid-ureteral lesions.[5] The surgical options for treating such defects can be divided into urothelial- and non-urothelial-based reconstructions; the former option is always considered the preferable method, as it obviates the need for gastro-intestinal surgery.[9-11] In addition, use of the urothelium is also advatageous, it being a non-absorptive tissue, resistant to the inflammatory and potentially carcinogenic effects of urine.[12]

Review of the current literature reveals a paucity of data regarding urothelial-based reconstructions of the upper- and mid-ureter. Passerini-Glazel et al[11] reported a series of 74 patients with various ureteral defects, including distal lesions, while Baldie et al[13] excluded proximal strictures from their study. Simmons et al[14] reported mixed surgical approaches, including both urothelial- and non-urothelial-based reconstructions, altogether, while Wenske et al[15] have recently reported their surgical outcomes only for re-implantations and Boari flaps, excluding uretero-ureterostomies. Similarly, Mauck et al[2] reported their experience with Boari flaps for upper-ureteral strictures, probably serving as the only accurate reference for urothelial-based reconstructive surgery of upper-ureteral lesions. That group has essentially precluded uretero-ureterostomy as a valid option for reconstruction of upper-ureteral lesions and reported their experience with 12 patients, with followup of 12.8 months.

The aforementioned heterogeneous and limited data make it difficult to draw firm conclusions regarding the effectiveness of urothelial-based surgical reconstructions of upper- and mid-ureteral defects. Therefore, the present series can be considered unique, as it addresses a homogenous group with regard to the location of the ureteral pathology and the methods of ureteral reconstruction, and provides

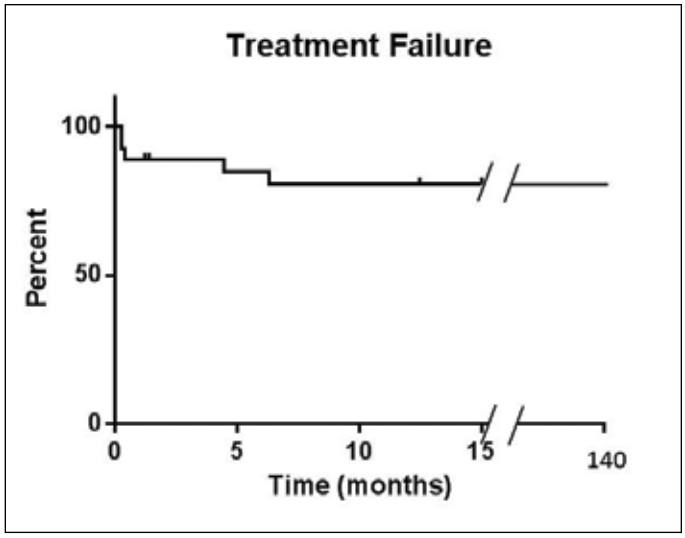

Fig. 2. Kaplan-Meier analysis for treatment failure (plot truncated to represent followup time; all failures occurred prior 12 months).

relatively long-term followup.

Our series showed eGFR to be generally improved or stable, while CKD stage deterioration was noted in six patients (19%), none of whom developed severe renal failure. Wenske et al reported similar results analyzing their whole cohort, while subanalysis of their data showed that preoperative renal function, age, and gender can serve as predictive factors for renal functional deterioration.[15] Subanalyzing our own data using the same criteria indeed showed that the four of the six patients with worsening eGFR were females. However, we found no correlation with age or preoperative renal functional impairment.

The five-year success rate of the procedure for the patients in our cohort was 84%. Such a surgical success rate is promising and comparable to the figures reported by other groups. Defining failure by the need for re-intervention, Wenske et al[15] described a success rate of up to 88%. Similarly, Mauck et al,[2] using the same definition, reported 83% success rate for upper ureteral lesions reconstructed by Boari flap, not including uretero-ureterostomy reconstructions.

The overall complication rate in our cohort was 23%. In comparison, Simmons et al[14] reported laparoscopic ureteral reconstructions with a nearly 15% complication rate, and Passerini-Glazel et al[11] reported an even lower complication rate using open surgical techniques. A recently published study by Wenske et al[15] shows a 3% rate for Clavien Grade III complications with a 1% death rate, not specifying the percentage for lower-grade complications. Despite the seemingly better outcomes, one must take into consideration that these series include re-implantation surgeries for distal-ureteral lesions (with or without psoas hitch in up to 50–82% of the patients), and are therefore not strictly comparable to our series.

Despite of the "field effect" and urothelial cancer tendency to multifocality, segmental resection for upper tract urothelial carcinoma is considered an acceptable alternative.[16,17] Analysis of our failed population subgroup showed no difference in failure and complication rates for benign and malignant stirctures as compared to the overall group (Fig. 3). These results are consistent with previous reports[18,19] and support the use of segmental resection and urothelial-based reconstructive surgery for upper- and mid-ureter urothelial cancer.

A 20% malignant etiology among the failed surgeries compared to the overall 19.5% of malignant lesions operated indicates such reconstructive procedures are safe and feasible, at least from the drainage point-of-view, in this subpopulation of patients. Such procedures, although technically challenging to perform, might offer the surgeon better tools for improving oncological patients' quality of life.

Furthermore, our study failed to identify a correlation between preoperative treatments, such as prior chemotherapy and irradiation, with the perioperative complication rate or success rate, although the actual influence of preoperative radiation as a risk factor for postoperative complications by itself has been questioned.[20] However, the lack of such correlation could be due to the small number of previously radiated patients in our cohort (three patients overall).

Subgroup analysis for uretero-ureterostomy surgery (20 patients, 65%) shows a success rate of 90% (18/20 patients) comparable to previously reported success rates of over 90%.[21,22] Current reccomendations for ureteral defects use the defect length as a cutoff for selecting the preferred surgical technique. Knight et al[5] recommended limiting uretero-ureterostomies to reconstruction of short proximal-ureteral strictures. Mauck et al[2] reported a relatively large series of upper-ureteral reconstructions using Boari flap with or without downward nephropexy following the same treatment algorithm. In our series, of 10 patients suffering from documented long ureteral defects (>2 cm), nine patients (90%) underwent uretero-ureterostomy. Out of this subgroup, only two (22%) had worsening eGFR levels (+13 and +8 ml/min/1.72m^2 difference, +26% and +27%, respectively. CKD Stage 2 to Stage 3 for both), one of whom was eventually drained by nephrostomy. Another patient was drained by nephrostomy due to urinary tract infection. The failure rate within this group was therefore 22% (two patients); the mean age in this subgroup age did not differ from that of the whole group.

The average time to failure was 2.3 months, suggesting a time limit of less than a year as a "safety cutoff," after which complications are no longer expected. Such one-year cutoff is consistent with previous publications,[14,23] although there have been reports of later-appearing complications.[24]

In our experience, applying the basic prinicples of successful anastomosis, a tension-free, watertight anastomosis, as described by others,[25] should also make urothelial-based reconstructions feasible for upper-ureteral lesions. In fact,

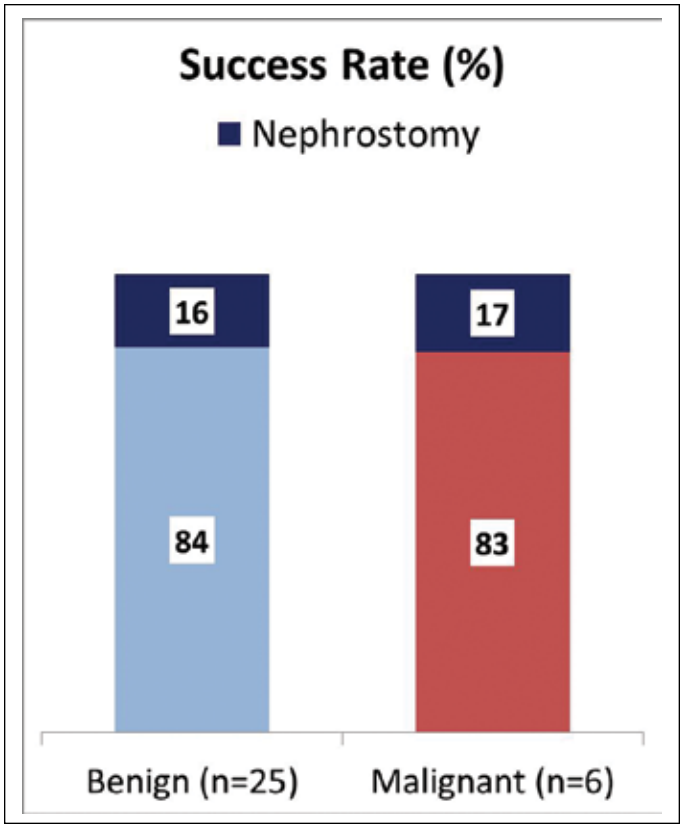

Fig. 3. Sucess rate (%) according to final pathology.

long-standing ureteral obstruction often results in a twisted, widened ureter, creating the "extra mile" needed to create the desired tension-free anastomosis.

Overall, the surgical success rate we achieved, together with the renal function preservation, suggest that ureter-ureterostomy should be considered as a legitimate reconstructive option for long upper-ureteral lesions.

The limitations of our study are its retrospective nature, the diversity of etiologies, patients' characteristics, and surgical techniques used. Despite the fact that our series is one of the largest ever published dealing with upper-ureteral reconstruction, it is still based upon a relatively small patient group, making formal statistical analysis inappropriate and certain conclusions, such as the influence of preoperative irradiation, difficult to investigate. However, considering the limited data regarding upper- and mid-ureteral reconstructive surgery, we do believe our long-term results are promising and support the use of urothelial-based surgery to preserve the involved renal unit.

Conclusion

Urothelial-based reconstruction surgery of upper- and mid-ureteral lesions results in effective long-term outcomes with acceptable associated complication rates. There are no preoperative exclusion criteria and postoperative failures tend to occur within the first year. These procedures therefore represent a valid therapeutic option for such complex pathologies and should be performed in high-volume centres with considerable experience in reconstructive urology.

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

This paper has been peer-reviewed.

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