Treatment of Complex Ureteral Strictures or Defects with Autologous Urinary Tract Muscle Flaps

Jianchen Wu (wujianchen0524@163.com)
Beijng Huaxin Hospital First Hospital of Tsinghua University https://orcid.org/0000-0001-6616-7194
Xuesong LI
Peking University First Hospital
Dong Pang
PLA Army General Hospital
Zhiqiang Song
Beijng Huaxin Hospital First Hospital of Tsinghua University
Shihai Li
Beijng Huaxin Hospital First Hospital of Tsinghua University
Biao Chen
Beijng Huaxin Hospital First Hospital of Tsinghua University
Wenjia Wang
Beijng Huaxin Hospital First Hospital of Tsinghua University
Shengwen Li
Beijng Huaxin Hospital First Hospital of Tsinghua University

Research article

Keywords: Ureteral strictures, ureteral defect, ureteral reconstruction, bladder muscle flap

Posted Date: August 31st, 2019

DOI: https://doi.org/10.21203/rs.2.13702/v1

Abstract

Background The surgical alternatives are complicated for complex ureteral strictures or long defects such as nearly full-length ureteral avulsion and recurrent ureteral strictures after pyeloplasty or ureteroplasty with severe local adhesion. This study was performed to summarize our clinical experience in the treatment of complex ureteral strictures or defects with autologous urinary tract muscle flaps. Methods We retrospectively analyzed seven patients with complex ureteral strictures or defects. The seven patients comprised three men and four women ranging in age from 37 to 61 years (average age, 46 years). The causes of ureteral lesions were nearly full-length ureteral avulsion (n = 2), postoperative ureteral stricture after sigmoid augmentation cystoplasty (n = 1), and postoperative recurrent ureteral stricture due to local inflammation and local adhesion (n = 4). The lengths of the defects in the patients with ureteral avulsion were 22 and 24 cm, and the average length of the recurrent ureteral strictures was 5.2 cm (range, 4–8 cm). The patients underwent ureteroplasty using spiral bladder muscle flaps (n = 4), muscle flaps from the dilated ureter or pelvis segment proximal to the strictures (n = 2), or a bowel segment (sigmoid) (n = 1). Six-French double-J stents were placed in the repaired ureters. Results All operations were successful, and the ureteral double-J stents were safely removed under cystoscopy 8 weeks postoperatively. All of the patients had improvement of hydronephrosis, and none had ureteral strictures on intravenous urography or contrast CT. The patient with failed pyeloplasty was found to have enlarged kidney and dilated calyx postoperatively, but the degree was less severe than preoperatively and three-dimensional CT reconstruction showed renal pelvis reduction and a patent ureter with no stenosis at the reconstruction site. Renal function was normal in all patients. Conclusions Treatment of ureteral strictures or defects with autologous urinary tract muscle flaps can be performed in some complicated cases with good results.

Introduction

Ureteral strictures or defects have many causes, including iatrogenic injury, trauma, chronic inflammation, congenital diseases, and tumors. Various management techniques can be undertaken depending on the length, position, and time of diagnosis of the ureteral lesions. Short-length defects or strictures can be managed directly via endoscopic ureteroureterostomy or ureteroneocystostomy with good results.

However, the surgical alternatives are more complicated for complex ureteral strictures or long defects, such as nearly full-length or full-length ureteral avulsion and recurrent ureteral strictures after pyeloplasty or ureteroplasty with severe local adhesion. Renal autotransplantation and ileal ureter replacement can be performed, but these treatment methods have limitations such as time-consuming preoperative bowel preparation, complex surgical procedures, and a variety of postoperative complications[1,2].

Ureteroplasty using a bladder muscle flap (Boari flap) was first applied clinically in 1947 and is typically used to repair <12-cm defects of the middle and lower ureter[3,4]. We modified this technique for application to nearly full-length ureteral defects and expanded the source of the muscle flap to include the dilated renal pelvis and dilated ureter segments. We herein describe seven patients with complex ureteral strictures or defects who underwent treatment with autologous urinary tract muscle flaps and subsequent long-term follow-up and outcome assessment.

Methods

Ethical approval

This study was approved by the Ethics Committee of the First Hospital of Tsinghua University.

Patients

We studied seven patients (three men, four women) with complex ureteral strictures or defects from September 2007 to August 2018. The patients' ages ranged from 37 to 61 years (average, 46 years). The inclusion criteria were (1) ureteral strictures or defects longer than 20 cm or recurrent ureteral strictures after pyeloplasty or ureteroplasty with severe local adhesion, (2) unfitness for or a history of failed endoscopic management, and (3) ureteral strictures or defects unsuitable for direct ureteroureterostomy or ureteroneocystostomy.

The patients' disease characteristics included nearly full-length ureteral avulsion (n = 2), postoperative ureteral stricture after ureterosigmoidostomy in sigmoid augmentation cystoplasty (n = 1), and recurrent ureteral stricture after surgery due to inflammation and local adhesion (n = 4). The reasons for the first surgery in these four patients were ureteropelvic junction obstruction (n = 1), ureteral stricture after lithotripsy (n = 2), and inflammatory ureteral stricture (n = 1). The lengths of the defects in the patients with ureteral avulsion were 22 and 24 cm, and the average length of the recurrent ureteral strictures was 5.2 cm (range, 4–8 cm). The lesions were on the left side in five patients and on the right in two patients. The ureteral stricture locations were the proximal ureter (n = 1), middle ureter (n = 2), distal ureter (n = 2), and nearly the full length of the ureter (n = 2).

Surgical technique

All seven patients underwent ureteroplasty with autologous urinary tract muscle flaps, including five bladder muscle flaps, one muscle flap from the dilated ureter, and one muscle flap from the dilated renal pelvis.

Spiral bladder muscle flaps were used to treat ureteral avulsions and long-segment ureteral strictures. The patients were placed in the supine position and tilted 30º to 45º on the affected side. A 20-Fr triple-lumen Foley urethral catheter was inserted prior to the surgery. An oblique incision was made in the lower abdomen and extended upward or toward the lateral side of the abdomen when necessary. The retroperitoneal space was exposed and the umbilical ligaments were resected. The bladder was fully mobilized by resection of peritoneal adhesions, the vas deferens, or the round ligaments. The superior vesical artery and its branches were identified and protected. The ureter was identified and dissected to the level of the lesion while ensuring preservation of the periureteral adventitia.

The bladder was filled with 400 mL of normal saline through the urinary catheter, and the bladder muscle flap was designed according to the length of the ureteral lesion (Figure 1). The lateral wall of the bladder was anchored to the psoas muscle. A spiral muscle flap was fashioned from the anterior and contralateral bladder wall. The total length of the muscle flap was approximately 1 cm longer than the ureteral lesion. The bladder muscle flap was sutured continuously with interrupted stitches using 4–0 bioabsorbable sutures to form a new ureter. The tip of the reconstructed new ureter was anastomosed to the proximal part of the native ureter using 4–0 bioabsorbable sutures. To reduce tension at the anastomosis site, the reconstructed ureter was fixed to the sarcolemma of the psoas muscle using three 1–0 Vicryl sutures. A 6-Fr double-J stent was placed.

In patients with nearly full-length ureteral avulsion, the kidney was mobilized to shorten the length of the ureteral defect. In the patient with a postoperative ureteral stricture after ureterosigmoidostomy in sigmoid augmentation cystoplasty, the muscle flap of the sigmoid neobladder was marked and incised; it was then sutured with 4–0 bioabsorbable sutures to form a tubular structure, which was anastomosed to the proximal part of the native ureter.

In one patient with recurrent ureteral stricture after surgery, the bladder muscle flap could not be used because of reduced bladder capacity. The ureteral stricture segment was incised longitudinally, and a muscle flap from the wall of the significantly dilated ureter proximal to the stricture was designed and dissected. The tip of the flap was rotated downward and anastomosed to the sides of the incised ureter. A 6-Fr double-J stent was placed. In the patient with recurrent ureteral stricture after pyeloplasty, the length of the stricture was about 4 cm with severe local adhesion, and direct anastomosis of the two ends could not be performed. A spiral renal pelvic flap was made with its base at the lower portion of the pelvis (Figure 2). The flap was trimmed, rotated downward, and anastomosed to the longitudinally incised ureteral stricture. The pelvis was closed using bioabsorbable 40 sutures with a round body needle in a continuous fashion. A 6-Fr double-J stent was placed.

All seven patients were evaluated for a duration of 5 months to 11 years after surgery. The evaluations were performed at 3 and 6 months postoperatively and yearly thereafter. Routine urine tests and serum tests for measurement of creatinine and electrolyte levels were performed. Ultrasonography of the urinary system, intravenous urography, or computed tomography (CT) was also performed to evaluate the morphology and function of the reconstructed ureter. Ureteroscopy was optional.

Postoperative assessment and follow-up

All seven operations were completed successfully. The mean operation time was 245 minutes (range, 180–340 minutes). The average estimated blood loss was 95 mL (range, 50–150 mL), and no patients required a blood transfusion. No intraoperative complications or immediate postoperative complications occurred. The patients were mobilized from postoperative day 1, and the indwelling catheters were kept in place for 10 to 14 days. The double-J stents were removed via cystoscopy 8 weeks after surgery. No patients developed a fever or renal colic after removal. The ureteral tissue pathology report of four patients revealed chronic inflammation.

During the follow-up period of 5 months to 11 years, all of the patients had improvement of hydronephrosis, and none had ureteral strictures on intravenous urography or contrast CT (Figure 3). The patient with failed pyeloplasty was found to have enlarged kidney and dilated calyx postoperatively, but the degree was less severe than preoperatively. In this patient, three-dimensional CT reconstruction showed renal pelvis reduction and a patent ureter with no stenosis at the reconstruction site (Figure 4). No ureteral stenosis or aggravation of hydronephrosis was found during regular checkups. All patients' serum creatinine and electrolyte levels were normal, and no patients, including the patient who had undergone sigmoid augmentation cystoplasty, had acid–base imbalance.

Discussion

Surgeons making decisions regarding the appropriate treatment strategy for ureteral stricture or defects should consider the stricture or defect length, location, and etiology; previous treatments; and the patient's general health status.

For patients with short ureteral strictures or defects, treatment can usually be carried out by endoscopic retrograde or antegrade dilation and resection of the stenosed segment followed by ureteroureterostomy or ureteroneocystostomy. These are widely accepted surgical techniques.

At present, the most difficult problems in clinical treatment are long ureteral strictures or defects such as full-length ureteral avulsion and recurrent adhesion strictures after multiple operations making direct anastomosis impossible. Such lesions lead to challenging clinical management and poor outcomes.

In this study, seven patients, depending on the length of their stricture or defect, were managed with either a bladder muscle flap or a dilated ureter or renal pelvis flap proximal to the stricture, specially designed and used for ureteral reconstruction. The local injury was relatively small, and bowel function was normal. After long-term follow-up, the surgical outcome was satisfactory.

For long-segment ureteral lesions, the simplest approach is to create a cutaneous ureterostomy; however, this is associated with complications including recurrent retrograde infection, peristomal skin infection, and poor quality of life. Thus, this method is not readily accepted by patients except in cases of temporary or palliative treatment. Ureteral replacement with a bowel segment is a surgical option, but the procedure is challenging and complex. The procedure not only disrupts the normal digestive tract but can also cause mucus obstruction of the urinary tract secondary to intestinal fluid secretion, metabolic and electrolyte disorders due to intestinal absorption of urine components, recurrent infection, decreased renal function, and other complications. Among these, the incidence rate of hyperchloremic metabolic acidosis is as high as 19.5%[2,7–9].

Although autologous renal transplantation has been used in the treatment of long ureteral defects, the surgical incision is long and the procedure is complex. Kidney transplantation into the patient's iliac fossa also affects the patient's quality of life[1]. The buccal mucosa can also be used to repair ureteral strictures or defects, but tissue harvest is limited and usually suited for ureteral lesions shorter than 8 cm [10].

Using autologous urinary tract tissue for ureteral reconstruction is more reasonable from the viewpoint of anatomical structure and histocompatibility, with the bladder muscle flap being the most widely used.

The bladder blood supply is abundant and has a meshwork-like pattern; thus, the survival rate of bladder flaps for replacement of ureteral defects is high. In 1894, Boari first described the use of a bladder flap for ureteral reconstruction in experimental animals, and in 1947 reported its use in humans with good results [3]. With the advent of minimally invasive surgery, laparoscopic ureteroplasty using a bladder flap is becoming more widely developed[4,5]. However, the above studies reported limitations with the use of bladder flaps to treat long ureteral strictures or defects because such flaps are usually used for ureteral strictures or defects ranging in length from 8 to 12 cm. The conventional use of bladder flaps for ureteral reconstruction of nearly full-length defects is difficult. In four patients of the present study, a spiral bladder flap combined with the psoas hitch technique was used to treat long ureteral strictures or defects, with an innovation to the conventional technique. During the preoperative assessment, a sufficient bladder capacity and an adequate amount of bladder wall for the bladder flap design should be ensured. The bladder capacity should be more than 500 to 600 mL. The bladder needs to be fully mobilized while protecting the bladder flap blood supply. Using the psoas hitch technique, the length of the ureteral defect can be shortened. The bladder flap is designed spirally starting from the highest point of the bladder flap anchorage on the bladder wall and then extending in an anterior, lateral, and posterior direction to ensure a sufficiently long pedicle muscle flap for anastomosis. The bladder flap is fixed at multiple points to the psoas muscle along the ureteral route to reduce tension during ureteroureterostomy. In some patients, the affected kidney can be mobilized and lowered, which can reduce the anastomosis length by about 3 to 5 cm[11]. In addition, studies have shown a reduction in the incidence of ischemic necrosis by using a pedicled greater omentum graft to cover the bladder flap[12,13].

For patients with an insufficient bladder capacity and a risk of an insufficient bladder flap length, the bowels can be prepared preoperatively so that a procedure involving a combination of a spiral bladder flap, the hitch technique, and an ileal segment for ureteral replacement can be used if necessary [14].

In one patient with recurrent lower ureteral stricture following sigmoid bladder augmentation, the pedicled bowel was rolled into a tubular shape and anastomosed with the proximal part of the ureteral stenosed segment.

Other than using a pedicled bladder flap, the significantly dilated pelvis and ureteral segments proximal to the stricture can be used as pedicled urinary muscle flaps for ureteral reconstruction. In one patient with recurrent middle ureteral stenosis with severe local adhesion, insufficient bladder capacity, and a stenosed segment distant from the bladder, the use of a bladder flap was relatively difficult. A dilated ureteral segment pedicle flap proximal to the stricture was chosen for ureteral reconstruction, yielding satisfactory results.

In one patient with recurrent ureteropelvic stricture following surgery, the significantly dilated renal pelvis was used. A spiral renal pelvis flap was designed according to the measured length of the ureteral stricture and then trimmed to size. The flap had a broad base to guarantee an adequate blood supply, which was used for ureteral reconstruction. The postoperative results were satisfactory. In addition, in a study by Kumar et al., the significantly dilated renal pelvis segment was used in the management of hydronephrosis secondary to ureteropelvic obstruction. Renal function was normal at 5 months postoperatively, and urinary tract contrast CT revealed good contrast excretion[15].

In conclusion, for long-segment, complex ureteral strictures or defects, the adjacent bladder wall, dilated renal pelvis, or ureteral segment wall can be used depending on the etiology, location and length of the lesion. Ureteral reconstruction can be accomplished with accurate measurement and flap design. In the present study, long-term follow-up revealed satisfactory results; therefore, treatment of ureteral strictures or defects with autologous urinary tract muscle flaps can be performed in some complicated cases with good results.

References

1. Tran G, Ramaswamy K, Chi T, Meng M, Freise C, Stoller ML. Laparoscopic nephrectomy with autotransplantation: safety, efficacy and long-term durability. J Urol. 2015;194(3):738–43. doi: 10.1016/j.juro.2015.03.089.
2. Kocot A, Kalogirou C, Vergho D, Riedmiller H. Long-term results of ileal ureteric replacement: a 25-year single-centre experience. BJU Int. 2017;120(2):273–9. doi: 10.1111/bju.13825.
3. Ockerblad NF. Reimplantation of the ureter into the bladder by a flap method. J Urol 1947;57:845–7.
4. Castillo OA, Travassos J, Escobar JF, Lopez-Fontana G. Laparoscopic ureteral replacement by Boari flap: multi-institutional experience in 30 cases. Actas Urol Esp. 2013;37(10):658–62. doi:10.1016/j.acuro.2012.11.017.
5. Bansal A, Sinha RJ, Jhanwar A, Prakash G, Purkait B, Singh V. Laparoscopic ureteral reimplantation with Boari flap for the management of long-segment ureteral defect: A case series with review of the literature. Turk J Urol. 2017;43(3):313–8. doi: 10.5152/tud.2017.44520.
6. Maigaard T, Kirkeby HJ. Yang-Monti ileal ureter reconstruction. Scand J Urol. 2015;49(4):313–8. doi: 10.3109/21681805.2014.882980.
7. Yang WH. Yang needle tunneling technique in creating antireflux and continent mechanisms. J Urol. 1993;150(3):830–4.
8. Monti PR, Lara RC, Dutra MA, de Carvalho JR. New techniques for construction of efferent conduits based on the Mitrofanoff principle. Urology. 1997;49(1):112–5. doi: 10.1016/S0090–4295(96)00503–1.
9. Liu D, Zhou H, Hao X, Cao H, Ma L, Zhou X, et al. Laparoscopic Yang-Monti ureteral reconstruction in children. Urology. 2018;118:177–82. doi: 10.1016/j.urology.2018.04.034.

10. Zhao LC, Weinberg AC, Lee Z, Ferretti MJ, Koo HP, Metro MJ,et al. Robotic ureteral reconstruction using buccal mucosa grafts: a multi-institutional experience. Eur Urol. 2018;73:419–26. doi: 10.1016/j.eururo.2017.11.015.
11. Hofer MD, Aguilar-Cruz HJ, Singla N, Cordon BH, Scott JM, Morey AF.Expanding Applications of renal mobilization and downward nephropexy in ureteral reconstruction. Urology. 2016;94:232–6. doi: 10.1016/j.urology.2016.04.008.
12. Tang K, Sun F, Tian Y, Zhao Y. Management of full-length complete ureteral avulsion. Int Braz J Urol. 2016;42(1): 160–4. doi: 10.1590/S1677–5538.IBJU.2015.0372.
13. Grzegółkowski P, Lemiński A, Słojewski M. Extended Boari-flap technique as a reconstruction method of total ureteric avulsion. Cent European J Urol. 2017;70(2):188–91. doi: 10.5173/ceju.2017.927.
14. Zhong W, Du Y, Yang K, Meng S, Lin R, Li X, et al. Ileal Ureter Replacement Combined With Boari Flap-Psoas Hitch to Treat Full-Length Ureteral Defects: Technique and Initial Experience. Urology. 2017;108:201–6. doi: 10.1016/j.urology.2017.07.014.
15. Kumar S, Singh S, Kumar N. Robot-assisted “Santosh-Post Graduate Institute tubularized flap pyelovesicostomy” in a solitary functioning kidney with giant hydronephrosis: A minimally invasive salvage procedure. Investig Clin Urol. 2016;57(2):141–5. doi: 10.4111/icu.2016.57.2.141.

Declarations

Acknowledgment: We thank doctor Wu Xin-Zi for drawing diagrams for the article.

Funding:No external source of funding.

Author information

Affiliations

Department of Urology, the First Hospital of Tsinghua University, Beijing 100016, China

Jianchen Wu,Zhiqiang Song, Shihai Li, Biao Chen, Wenjia Wang, Shengwen Li

Department of Urology, Peking University First Hospital, Beijing 100034, China

Xuesong Li

The 3rd Medical Center of Chinese PLA General Hospital, Beijing 100039, China

Dong Pang

Contributions

Jianchen Wu (concept, design, manuscript preparation and); Xuesong Li(design and operation); Dong Pang(literature search); Zhiqiang Song (data acquisition); Shihai Li (data analysis); Biao Chen (data acquisition); Wenjia Wang (manuscript editing); Shengwen Li (design, operation and manuscript review). All Authors read and approved of the final version being submitted and agreed to be accountable for all parts of the research work.

Corresponding author

Corresponding toJianchen Wu.(Department of Urology, the First Hospital of Tsinghua University, Beijing 100016, China. E-mail: wujianchen0524@163.com)

Ethics declarations

This study was approved by the Ethics Committee of the First Hospital of Tsinghua University. Written informed consent to participate was obtained from each participant.

Consent for publication

Not applicable.

Competing interests

No other conflicts of interest declared.

Statement:

the manuscript has been read and approved by all the authors, and that each author believes that the manuscript represents honest work.

Figures

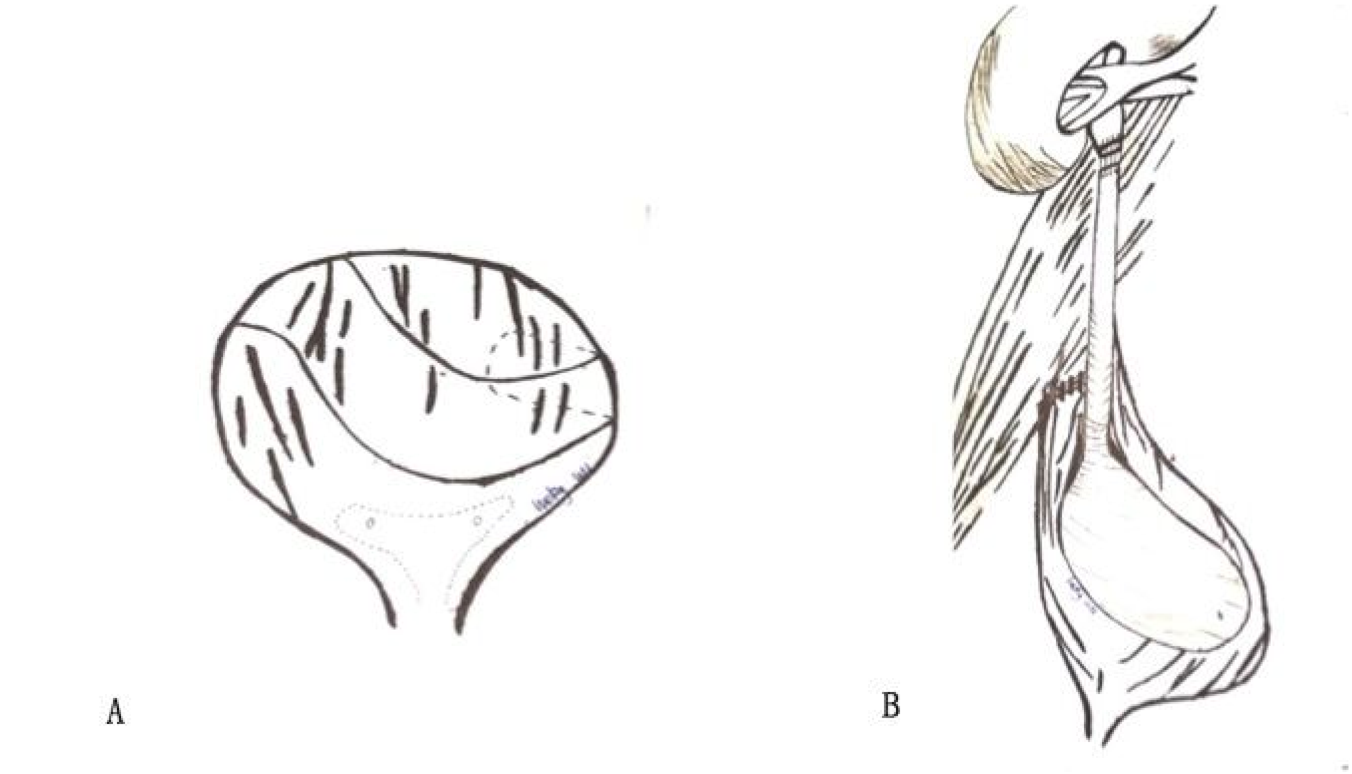

Figure 1

Figure 1. Schematic diagram of ureteroplasty using a spiral bladder muscle flap.

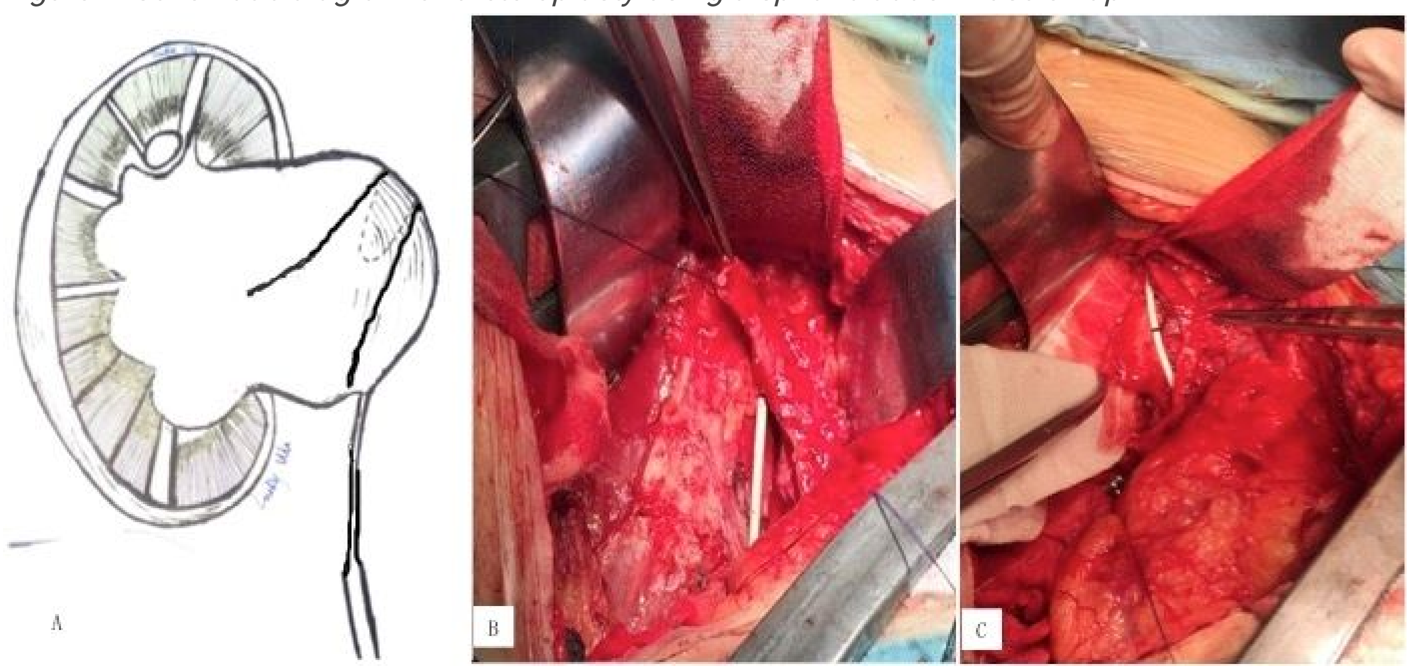

Figure 2

Figure 2. Ureteroplasty using a spiral renal pelvic muscle flap in a patient with failed pyeloplasty. A: Designation of the spiral renal pelvic flap. B: The freed and trimmed spiral flap (arrow). C: Anastomosis of the spiral flap with the longitudinally incised ureteral stricture.

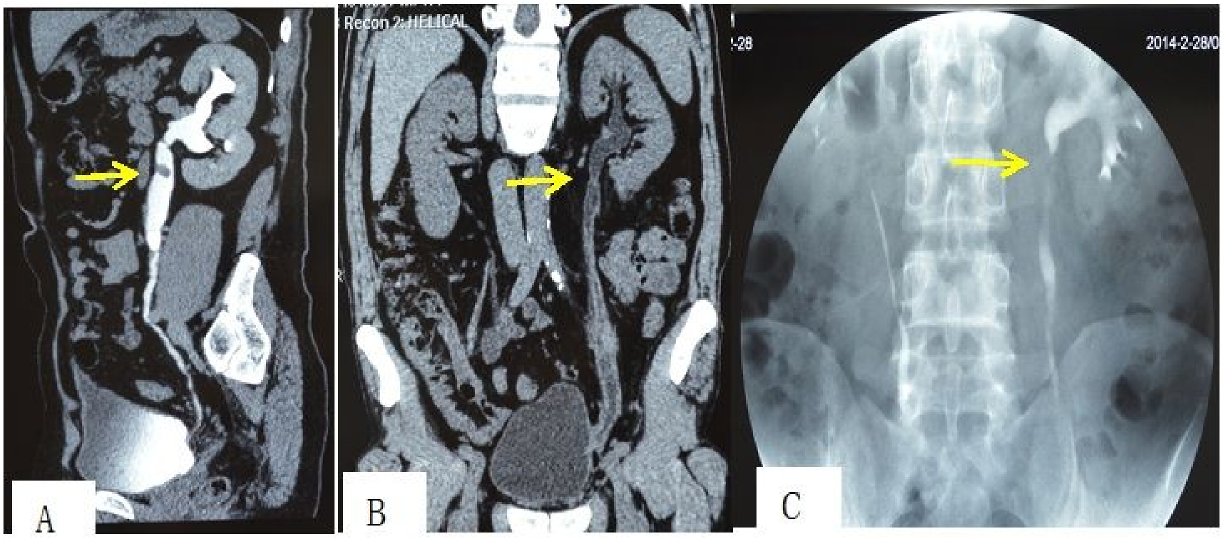

Figure 3

Figure 3. Preoperative and postoperative imaging in a patient who had undergone ureteroplasty using a spiral bladder muscle flap. A: Preoperative contrast computed tomography revealed the site of the ureteral lesion (the site of the ureteral avulsion, arrow). B: Postoperative computed tomography showed normal morphology of the reconstructed ureter. C: Postoperative intravenous urography indicated that the reconstructed ureter on the surgical side exhibited normal morphology without stenosis.

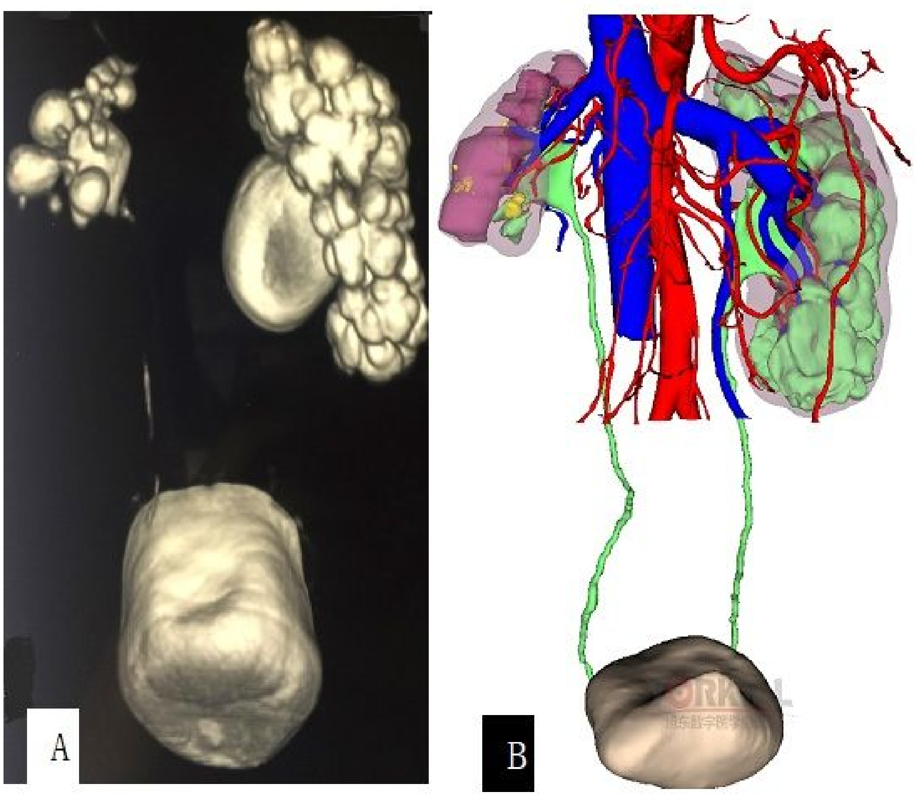

Figure 4

Figure 4. Preoperative and postoperative imaging of a patient who had undergone ureteroplasty using a spiral renal pelvic flap. A: Preoperative contrast computed tomography revealed complete obstruction of the upper ureter before the operation. B: Postoperative computed tomography with three-dimensional reconstruction showed that the ureter was well imaged with shrinkage of the renal pelvis.