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Laparoscopic Ureteral Reimplantation: A Single Center Experience and Literature Review

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Abstract

Background: Laparoscopic Boari flap, psoas hitch, and direct ureteral reimplantation have all been described in the management of benign distal ureteral strictures.
Patients and Methods: A retrospective review of a single center experience of laparoscopic reconstructive surgery for benign distal ureteral strictures was undertaken. The results of this initial series were compared with the published literature. To date, six patients with benign distal ureteral strictures have undergone laparoscopic reconstructive surgery at our center. Stricture etiology was stone disease in two patients, postvaginal hysterectomy in one patient, and unknown in the remaining two. In all cases, the operative procedure was undertaken with five-port transperitoneal access. Depending on healthy ureteral length, a decision for direct reimplantation was made in two patients, and Boari flap reconstruction was undertaken in the remaining three patients.
Results: Mean operative time was 322 minutes (range 240–360 min), which is longer than in the published literature, reflecting our initial learning curve in reconstructive laparoscopy. The mean drop in hemoglobin, however, was only 0.5 g/dL, which is comparable to that in other series. Further, there were no complications, and patients were discharged at a mean of 6.6 days postoperatively (range 5–9 days). All patients had satisfactory follow-up intravenous urograms with a mean follow-up period of 4 months.
Conclusion: Laparoscopic reconstructive surgery for managing benign distal ureteral strictures is both safe and effective. Although open surgery currently remains the gold standard for these patients, all operative steps can be replicated laparoscopically, and this may become the future standard treatment.

Introduction

Ureteral injury is a recognized complication of both pelvic and ureteroscopic surgery that occasionally necessitates a definitive reconstructive procedure. Depending on the length and position of the ureteral injury, end-to end anastomosis, ureteroneocystotomy with or without psoas hitch, Boari flap, ileal interposition, and autotransplantation have all been shown to work as open procedures.

More recently, laparoscopy has emerged as a viable alternative to open surgery in the management of ureteral injury. First described in a porcine model,[1] Fugita and colleagues[2] published the initial experience of laparoscopic Boari flap construction in humans in 2001. In 2008, however, the published laparoscopic experience of this often complex and challenging surgery remains limited.

We present our experience of managing distal ureteral injury laparoscopically and compare our results with those in the published literature.

Patients and Methods

After ethical approval, a retrospective study of all patients who had undergone laparoscopic ureteral reimplantation at our center was undertaken. Between October 2005 and December 2007, three men and three women were assessed at our institution for ureteral injury. Stricture etiology was stone disease that was managed ureteroscopically in two patients, bilateral ureteral injury as a complication of hysterectomy in two patients, and unknown in the remaining two patients (Table 1).

Preoperative laboratory evaluation included serum creatinine and hemoglobin levels and urine culture. Renal ultrasonographic scanning as well as antegrade and retrograde pyelography were performed in all patients. In one woman with anuria secondary to hysterectomy, bilateral antegrade and retrograde pyelography was followed by a successful left-sided rendezvous procedure and insertion of a Double-J stent.[3] Combined endoscopic alignment was also attempted

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Table 1. Patient Demographic and Clinical Data

Patient no.	*Age (years)*	*Sex*	*Initial presenting symptom*	*Surgical history*	*Preoperative nephrostomy*	*Imaging*	*Diagnosis*	*Stricture length (cm)*
1	22	Male	Flank pain	Known previous stone disease. URS attempted and failed three times. PCN placed.	Yes	1. USS 2. Antegrade and retrograde studies	Right long segment mid and distal ureteral stricture	6
2	46	Female	Anuria	Vaginal hysterectomy for menorrhagia. Immediate postoperative anuria necessitating hemodialysis before PCN placement.	Yes—bilateral	1. USS 2. Antegrade and retrograde studies	Bilateral distal ureteral strictures (left successfully managed by rendevous procedure)	2
3	41	Male	Flank pain	Ongoing pain after URS for stone disease necessitating PCN.	Yes	1. USS 2. Antegrade and retrograde studies	Left distal ureteral stricture	5
4	47	Female	Flank pain	Known stricture disease previously treated with stricturotomy and balloon dilatation at our center. Etiology unknown.	No	1. DTPA—deterioration in renal function on left side to 33% 2. USS 3. Antegrade and retrograde studies	Left distal ureteral stricture	4
5	43	Male	Flank pain and pyrexia	Failed URS with retrograde study demonstrating stricture. PCN placed. Etiology unknown.	Yes	1. USS 2. Antegrade and retrograde studies 3. Contrast CT	Left long segment mid and distal ureteral stricture	6
6	37	Female	Anuria	Abdominal hysterectomy for menorrhagia. Immediate ostoperative anuria.	Yes—bilateral	1. US 2. Antegrade and retrograde studies	Bilateral distal ureteral	2

URS = ureteroscopy PCN = percutaneous nephrostomy; USS = ultrasound scan; DTPA = diethylenetriamine pentaacetic acid; CT = computed tomography.

on the right side in this patient, but the procedure failed and was abandoned in favor of laparoscopic ureteral reimplantation.

Depending on stricture length and bladder capacity, three patients underwent direct ureteroneocystotomy (bilateral in one patient), and in three patients, a Boari flap was constructed. Operative time, hemoglobin drop, renal function, intraoperative and postoperative complications as well as hospital stay were all recorded. All patients underwent cystography before catheter removal. After discharge, patients were reviewed at 1 month for removal of the Double-J stent, and at 3 months, intravenous urography was performed in all patients. Ultrasonographic assessment is used routinely for patients on our postoperative wards and at all follow-up appointments as a noninvasive assessment for hydroureteronephrosis.

After this retrospective data collection in our own patients, a comparison was made of our results with those reported in the literature. Published data were identified through a Medline search of both laparoscopic "Boari flap" and "ureteroneocystotomy." All case reports and series where operative and postoperative data were presented are included here for comparison with our data.

Surgical technique

After appropriate counseling, including the risk of open conversion, patients are positioned supine under general anesthesia, and a Foley catheter is placed in the bladder under sterile conditions. All patients receive intravenous antibiotics. Veress needle insufflation is performed via a periumbilical incision, which is converted to an 11-mm camera port. A five-port technique is used, with further ports placed under direct vision, as shown in Figure 1.

Initially, the ipsilateral colon is reflected medially by incision along the line of Toldt, and the ureter is identified at the level of the crossing of the iliac vessels. The ureter is dissected free just above the level of fibrosis, and the dissection is continued caudally as far as possible. Dissection into such dense fibrotic tissue often necessitates sharp as well as blunt dissection.

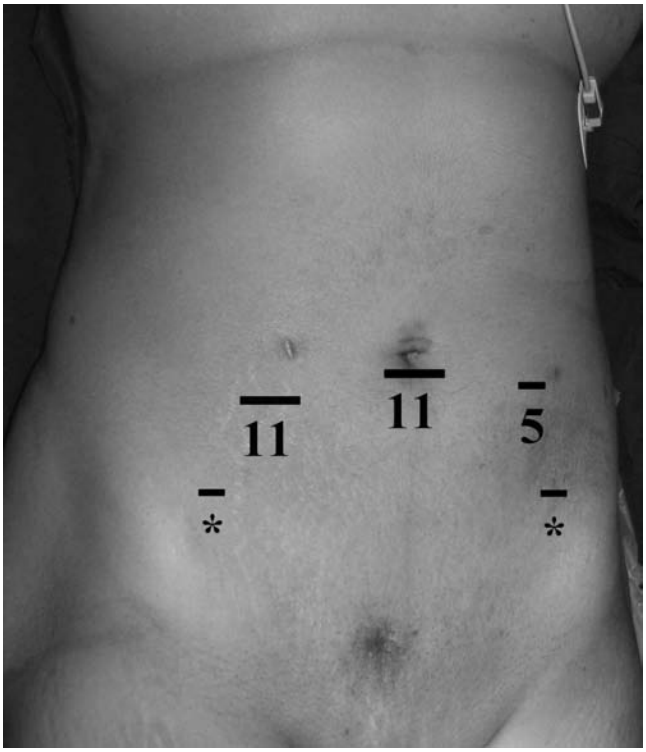


FIG. 1. Laparoscopic port site placement. Asterisk denotes optional 5 mm retraction port site placement.

The ureter is then transected as distally as possible. In cases in which stricture etiology is unknown, the diseased distal portion of the ureter is excised and sent for histopathologic evaluation. The healthy distal ureter is then mobilized for 3 to 4 cm proximally, ensuring preservation of periureteral adventitia to maximize blood supply. Distal spatulation is then performed in preparation for reimplantation.

The bladder is filled with 200 mL of saline, and the overlying anterior and lateral peritoneum is incised widely to enter the space of Retzius and drop the bladder posteriorly. The extent of bladder mobilization, both anteriorly and ip-

TABLE 2. PATIENT OPERATIVE DATA

Patient number	*Procedure*	*Operative time (min)*	*Hb drop (g/dl)*	*Complications*	*Analgesic requirement*	*Preoperative creatinine (mg/dL)*	*Post-op creatinine (mg/dL)*	*Hospital stay (days)*
1	Right laparoscopic Boari flap	360	1.1	None	200 mg diclofenac	1.1	1.0	7
2	Right laparoscopic ureteroneocystotomy	360	0.0	None	150 mg diclofenac	0.8	0.6	5
3	Left laparoscopic Boari flap	240	0.2	None	150 mg tramadol	1.5	0.8	9
4	Left laparoscopic ureteroneocystotomy	330	0.2	None	150 mg diclofenac	0.7	0.7	6
5	Left laparoscopic Boari flap	320	1.0	None	150 mg diclofenac	1.0	0.9	6
6	Bilateral laparoscopic ureteroneocystotomy	130	0.0	None	250 mg tramadol	0.9	0.6	10

Hb = hemoglobin.

FIG. 2. Postoperative cystogram after left laparoscopic Boari flap.

silaterally, is dependent on stricture length. Just as in open surgery, the contralateral superior vesical pedicle can be clipped and divided, if necessary, to achieve greater bladder mobility; however, this was not necessary in the three patients undergoing Boari flap construction in our series.

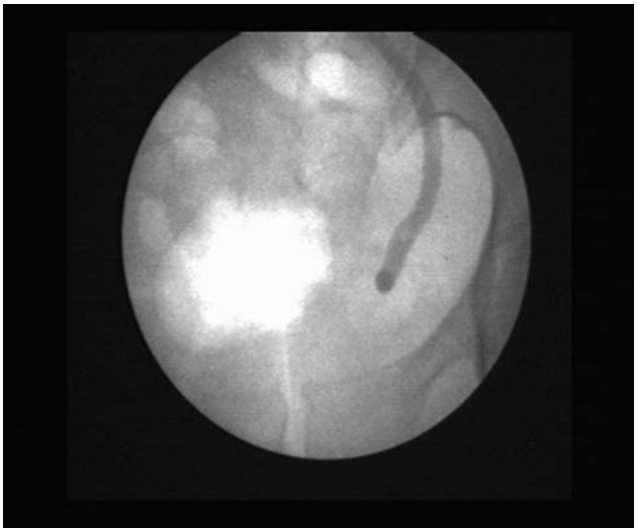
In patients with very distal strictures, a direct ureteroneocystotomy is performed. In those with longer segment and more proximal strictures, a Boari flap is undertaken. Where it is impossible to bridge the gap between ureter and bladder by the use of a Boari flap, our preference for reconstruction would be open ileal interposition.

In cases of laparoscopic Boari flap, after mobilization, the bladder is initially hitched to the ipsilateral psoas muscle. The gap between the distal ureter and bladder is then measured using a ureteral catheter passed via a laparoscopic port. An appropriately sized anterior bladder flap is then measured and marked out using point electrocautery, ensuring at least 3 cm at the base and 2 cm at the apex of the flap. Finally the bladder is opened, and flap dissection is undertaken along this previously marked line.

The spatulated ureter and bladder flap are anastomosed in a tension-free fashion posteriorly using a 4/0 polyglactin continuous suture technique. After completion of the posterior Anastomosis, a 6F 26-cm Double-J stent is passed into the ureter and advanced to the renal pelvis over a 0.035 inch guidewire via the contralateral 5-mm laparoscopic port. The distal end of the stent is placed comfortably in the bladder.

After stent placement, the cystotomy is closed, using a 4/0 polyglactin continuous suture that is continued to complete the anterior ureterovesical anastomosis. The anastomosis is leak tested by refilling the bladder, and further sutures are placed if necessary. A closed Nelaton drain is then placed in the paravesical space via the 5-mm laparoscopic port, and the anastomosis is covered using perivesical fat held in position with Hem-o-lok clips. Finally all 1-mm ports are closed in layers to prevent herniation.

A



B

FIG. 3. (**A**) Preoperative left-sided antegrade study and (**B**) 3-month postoperative intravenous urographic study after ureteroneocystotomy.

Results

Laparoscopic ureteroneocystotomy was completed in all patients without intraoperative complications or need for open conversion. The mean operative time (including anesthesia time) was 290 minutes (range 130–360 min) (Table 2). The mean drop in hemoglobin was 0.4 g/dL (range 0–1.1 g/dL) between preoperative and postoperative sampling; no patient needed blood transfusion. Postoperatively, pain control was not problematic in any patient, with a mean analgesic requirement of 160 mg of diclofenac. Mean time to oral intake was 20 hours. All patients made an uneventful recovery from their surgery.

Cystography was performed in all patients before removal of the catheter, none of which demonstrated any leak (Fig. 2). Mean hospital stay was 7.2 days (range 5–10 days). In the two patients with strictures of unknown etiology, histopathologic examination revealed fibrocollagenous tissue only.

Five patients had returned to normal activities by the time they were reviewed for stent removal at 1 month. Patient 5 resides in the United Kingdom (UK), where his initial diagnosis was made; he was therefore followed up in the UK only. A follow-up report from the local urologist regarding this patient was received at our institution, with no problems reported.

Mean follow-up for the remaining patients was 4 months. Ultrasonographic scanning in four patients showed no evidence of hydronephrosis, and in one patient, showed mild fullness of the pelvicaliceal collecting system at 3 months postoperatively. Intravenous urography at 3 months postoperatively demonstrated prompt bilateral excretion in all patients (Fig. 3b).

These results were compared with the reported literature on laparoscopic ureteroneocystotomy and Boari flap techniques (Table 3). Fugita and associates[2] reported the first human series of laparoscopic Boari flap in three patients in 2001. In 2005, Castillo and coworkers[4] reported a series of eight patients who underwent laparoscopic Boari flap for strictures that averaged 5.5 cm. A case report of a single laparoscopic Boari flap was presented by Modi and colleagues[5] in 2006.

In 2007, two retrospective studies were published comparing open and laparoscopic techniques for the management of distal ureteral stricture.[6,7] Rassweiler and associates[6] compared 10 patients who underwent laparoscopic vesicopsoas hitch with (n = 4) or without Boari-flap (n = 6) with 10 patients who were treated by open ureteroneocystotomy for similar pathologies; Simmons and colleagues[7] compared 12 patients who underwent laparoscopic ureteroureterostomy, ureteroneocystotomy, or Boari flap against 34 patients undergoing similar open procedures. For the purposes of this study, data from the laparoscopic groups only were taken for comparison. Most recently, Patil and associates[8] reported a multinational series of robot-assisted laparoscopic ureteral reimplantations by three different surgeons.

The results of our series were similar to other published data in terms of estimated blood loss, analgesia requirements, and hospital stay. The mean operative time in our series was longer than that shown by other authors. Our mean operative time, however, was within the operative time range shown by both Fugita and colleagues[2] and Rassweiler and coworkers.[6] Reported complications were low, which reflected our finding of no operative or postoperative complications.

Discussion

Laparoscopic and robot-assisted laparoscopic ablative surgery are now well entrenched in urologic practice and have clear advantages to the patient in terms of both cosmesis and decreased hospital stay. Reconstructive urologic surgery, however, remains largely performed by open techniques. One of the reasons for this is the technical demands faced by the surgeon in undertaking a reconstructive procedure laparoscopically, a complexity that is reflected in the lengthy operative times reported to date.

The published operative times cited in this study range between 120 and 345 minutes. Operative times in our series were slightly longer (130–360 min) than those of other authors, reflecting our learning curve in reconstructive laparoscopy. Operative time, however, was not found to be longer for patients needing a Boari flap as opposed to direct ureteroneocystotomy, which suggests that increased intracorporeal suturing did not significantly extend operative time.

In patient 6, the operative time was short at 130 minutes, despite a bilateral procedure. In this patient, because reim-

Table 3. Literature Comparison: Reported Series of Laparoscopic Ureteral Reimplantation

Reference	*Patient number*	*Mean operative time (min) (range)*	*Mean estimated blood loss (range)*	*Mean analgesia requirement*	*Hospital stay (days) (range)*	*Complications*
Castillo[4]	8	156 (120–240)	124 mL (20–200)	32 mg morphine	3 (2–4)	1—urine leak 1—pulmonary embolism
Fugita[2]	3	220 (120–330)	467 mL (400–600)	42.67 mg morphine	6.3 (3–13)	1—*Clostridium difficile*
Rassweiler[6]	10	228 (165–345)	370 mL (170–550)	4.9 mg piritramide	9 (6–19)	2—ileus
Modi[5]	1	210	90 mL	50 mg morphine	3	Nil
Simmons[7]	12	—	86 mL (50–200)	—	2.6 (2–3)	1—urinoma
Patil[8]	12 (robot-assisted)	208 (80–360)	48 mL (45–100)	—	4.3 (2–8)	Nil
Symons	6	290 (130–360)	0.42 g/dl Hb drop (0–1.1)	160 mg diclofenac	7.2 (5–10)	Nil

Hb = hemoglobin.

plantation was performed very shortly after the ureteral injury, dissection was straightforward in the absence of significant scar tissue. Further, this was the sixth case in our experience and well along our learning curve in reconstructive laparoscopic procedures.

Despite the technical challenge of undertaking reconstructive techniques laparoscopically, the advantages to patients of the minimally invasive approach remain. Each of the authors cited for comparison in this study has demonstrated not only the feasibility but also the safety and efficacy of both the laparoscopic and robot-assisted laparoscopic approach. Our experience corroborates this evidence.

No complications were experienced by the patients in our series, and all demonstrated satisfactory results on follow-up intravenous urography. Furthermore, there may be an additional advantage of the laparoscopic approach to the distal ureteral stricture: Both Fugita and colleagues[2] and Castillo and coworkers[4] noted that the magnification provided by laparoscopy facilitated ureteral dissection and bladder mobilization despite often extensive pelvic fibrosis in such patients.[2,3]. It is our impression also that the visualization gained during laparoscopy benefited ureteral and bladder mobilization, enabling an adequate bladder flap and tension-free anastomosis to be created.

Whether an antireflux mechanism is needed as part of a ureteral reimplantation procedure will depend on the individual clinical scenario. The feasibility of creating an antireflux mechanism laparoscopically has been well demonstrated by both Simmons and associates[9] and Rassweiler and coworkers,[6] although Simmons and colleagues[9] noted that its use is limited to patients with adequate ureteral length.[6,9] It is accepted that persistent reflux in adults without urinary tract infection does not result in renal deterioration, and for this reason, no patient in our series received an antireflux mechanism.

In addition to our experience in benign ureteral strictures, and to that of the authors cited here, the technique of laparoscopic ureteral reimplantation has now been extended to malignant disease. Uberoi and coworkers[10] described robot-assisted laparoscopic distal ureterectomy and reimplantation in patients with mid- and distal-ureteral tumors that were not amenable to endoscopic resection. We have no experience of laparoscopic ureteral reimplanatation in malignant disease at our center. Although feasible, we feel long-term follow-up is undoubtedly necessary to determine the safety of such an intraperitoneal approach in transitional-cell carcinoma.

Conclusions

Laparoscopic ureteral reimplantation is a feasible procedure with good functional short-term outcomes. The creation of both ureteroneocystotomy and Boari flap require advanced laparoscopic skills, and a definite learning curve exists in mastering such techniques. Larger series with longer follow-up are still necessary to validate the results of this procedure against open surgery.

Disclosure Statement

No competing financial interests exist.

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Abbreviation Used

UK = United Kingdom