Single-port robotic laparoscopic ureterocalicostomy: surgical technique and clinical outcomes

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Introduction: *We describe a method of robotic ureterocalicostomy (RALUC) with the Da Vinci Single Port (SP) platform and present clinical outcomes in our cohort of patients.*

Materials and methods: *We retrospectively reviewed all patients undergoing RALUC with the SP platform in a single-institution, IRB-approved database between 2020-2023. Demographics, preoperative, intraoperative, and postoperative outcomes were collated. Surgical success was defined as freedom from hardware, avoidance of additional surgical reconstruction, and no obstruction on follow up imaging/ureteroscopy.*

An incision is made 1/3rd the distance from anterior superior iliac spine to the umbilicus. The retroperitoneal space is entered and SP Access Port is placed. The psoas is identified and concomitant ureteroscopy is used to identify the ureter. The ureter is dissected to the most proximal aspect and transected. The remaining proximal ureteral stump is suture ligated. The lower pole parenchyma is removed to access the calyx. Absorbable barbed suture is used to control parenchymal bleeding and evert the mucosal edge of the calyx. Barbed suture is then used for the ureterocaliceal anastomosis over a ureteral stent.

Results: *Six patients underwent RALUC. Retroperitoneal approach was used for 5/6 cases. Prior ureteral surgery had been performed in 4/6 patients. Fifty percent of cases included an additional procedure with a median operative time of 248 minutes. One patient required nephrostomy tube placement postoperatively. Median follow up was 10.35 months with surgical success rate of 67%.*

Conclusions: *SP RALUC is a safe and feasible option for proximal ureteral reconstruction in patients with unfavorable upper urinary tract anatomy or in salvage cases.*

Key Words: reconstruction, ureterocalicostomy, ureteral reconstruction, robotics, pyeloplasty

Introduction

Ureterocalicostomy was initially described in 1948 by Neuwirt[1] and has traditionally been utilized in cases of a ureteropelvic junction obstruction (UPJO) associated with a small intrarenal pelvis, a congenital anatomic anomaly, or in salvage cases after failed pyeloplasty. More recently, laparoscopic and robotic approaches have been described in both adult and pediatric populations though published studies are primarily case reports or small cohorts. Here we describe our surgical technique for robotic-assisted laparoscopic ureterocalicostomy (RALUC) using the Da Vinci (Intuitive; Sunnyvale, CA, USA) Single Port (SP) platform and a primarily retroperitoneal approach in a cohort of six adult patients.

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A video clip is available online at www.canjurol.com

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Materials and methods

A retrospective review was conducted of all patients who underwent RALUC with the SP platform at our institution in a prospective, IRB-approved database between 2020 and 2023. Demographics, preoperative, intraoperative, and postoperative outcomes were collated, and surgical success was defined as freedom from hardware at follow-up, avoidance of additional surgical reconstruction, and no obstruction on follow up imaging/ureteroscopy. Since not every patient underwent a renal scan prior to surgery, we have defined obstruction as evidence of worsening hydronephrosis on upper tract imaging or declining split function on renal scan as compared to preoperative studies.

Surgical technique, Figure 1

After the induction of general anesthesia, male patients are positioned supine while female patients are positioned in dorsal lithotomy for urethral access. A 3 cm incision is made 1/3rd of distance from anterior superior iliac spine to the umbilicus. The SP Access Port is placed within the incision and the retroperitoneal space entered. Our instrument configuration is as follows: SP endoscope at 6 o'clock, monopolar curved scissors at 9 o'clock, needle driver at 12 o'clock, and Maryland bipolar at 3 o'clock. The 3 and 9 o'clock positions are switched based on laterality, Figure 2. The psoas is identified and concomitant ureteroscopy is used to identify the ureter with near infrared fluorescence imaging. The ureter is transected at the most proximal aspect. The lower pole parenchyma is identified using ultrasound guidance and defatted. The parenchyma is then dissected down to the calyx and the calyx sharply incised. Circumferential horizontal mattress sutures using 3-0 Stratafix (Ethicon; Raritan, NJ, USA) are used both to control parenchymal bleeding and evert the mucosal edge of the calyx in preparation for anastomosis. The kidney is further mobilized posteriorly, anteriorly, and laterally with care taken to avoid the hilum. Adjunct procedures such as downward nephropexy or ureteroplasty can be performed if renal mobilization is not adequate. The percutaneous nephrostomy tube (PCNT), if present, may be removed to further aid with mobilization. The proximal ureter is transected and mobilized distally to ensure a tension-free anastomosis. The remaining stump of the renal pelvis or ureter is ligated. Ureterocalicostomy was then performed with a double armed 4-0 Stratafix suture. A leak test is performed to confirm a watertight anastomosis and a ureteral stent is placed. Finally, the perinephric fat is closed over the repair.

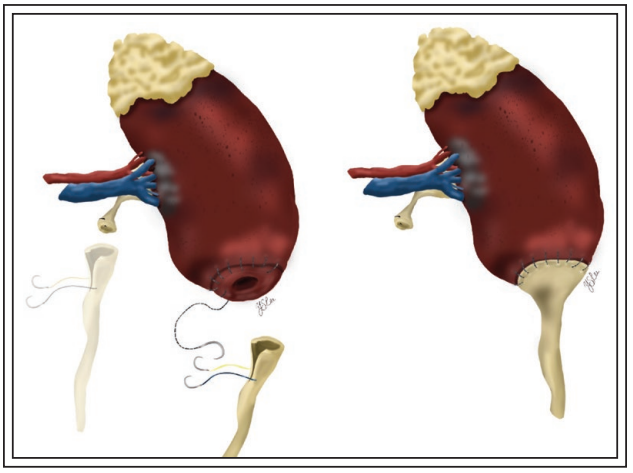

Figure 1. Operative technique. Ureterocalicostomy is a useful technique when scar of the renal pelvis precludes reconstruction with the renal pelvis. Thus, the proximal ureter is transected below the area of scar, where it is safe below the hilar structures **(left)**. The dilated lower pole calyx is then identified using intraoperative ultrasound. A barbed suture is used to ligate any bleeding from the parenchyma and evert the calyceal mucosa. The ureterocalicostomy is then performed with a double-armed barbed suture **(right).**

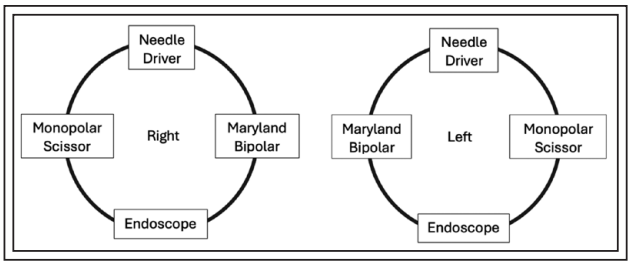

Figure 2. Robotic instrument position for the SP RALUC approach is dependent on laterality of the procedure.

Follow-up imaging protocol is as follows: renal ultrasound at 1 months, renal scan at 3 months, ultrasound at 6 months, 12 months, then annually thereafter.

Results

Key characteristics of our cohort are shown in Table 1. A total of six patients underwent RALUC with median age of 47 years (range 19-68) and an equal distribution of male and female patients. Median BMI was 22.7 kg/m^2

TABLE 1. **Patient demographics, preoperative stricture characteristics, perioperative and postoperative outcomes of all patients undergoing single port robotic ureterocalicostomy**

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Total
Age (years)	19	54	68	62	19	40	Median: 47
Gender	Female	Female	Male	Male	Male	Female	50% female
BMI (kg/m^2)	22.6	25.7	22.7	22.0	18.0	48.0	Median: 22.7
Comorbidities*	None	None	None	None	None	None	100% without
Location†	Right UPJ	Left UPJ	Left UPJ + distal	Right proximal + distal	Left UPJ	Right proximal	50% UPJ 33.3% distal + proximal 16.7% proximal
Prior reconstruction	Open pyeloplasty	Balloon dilation	Endopyelotomy and balloon dilation	None	Robotic pyeloplasty	None	33.3% prior pyeloplasty 33.3% prior endoscopic
Drainage prior to surgery	None	PCNT	PCNT	PCNT	PCNT	PCNT	83.3% with PCNT
Time from diagnosis to intervention (months)	12	4	3	9	8	2	Median: 6
Access	Supraumbilical intraperitoneal	Left retroperitoneal	Left retroperitoneal	Right retroperitoneal	Left retroperitoneal	Right retroperitoneal	83.3% retroperitoneal
Assistant Port	12 mm right lower quadrant	8mm left lateral	8mm left lateral	None	None	None	50%
Adjunctive procedure	None	Inferior nephropexy	Side-to-side distal ureteral reimplant	Buccal graft ureteroplasty, distal reimplant with Boari flap	None	None	50%
Operative time (minutes)	192	324	300	300	197	172	Median: 248.5
Peri- or post-operative transfusion requirement	None	None	None	None	None	None	100% without transfusion
Peri-operative complication	None	None	None	None	None	Clavien 3b: nephrostomy for urinary leak	83.3% without complications
Length of stay (days)	1	0	1	1	2	0	Median: 1
Duration of follow-up (months)	51.6	27.1	7.3	13.4	1.1	3.9	Median: 10.35
Duration of ureteral stent (weeks)	4	3	2	12	4	5	Median: 4
Additional procedure after index surgery?	Endoscopic balloon dilation 11 mos. post-op	Endoscopic balloon dilation 4 mos. post-op	None	Diagnostic ureteroscopy 10 mos. post-op	None	None	50% without additional procedure
Hardware-free at last follow-up?	Yes	Yes	Yes	Yes	No – PCNT	Yes	83.3% hardware free
Obstruction# at last imaging?	No	No	No	Yes	Yes	No	66.7% no obstruction
Outcome^	Success	Success	Success	Failure	Failure	Success	66.7% success

Table 1: Patient demographics, pre-operative stricture characteristics, peri-operative and post-operative outcomes of all patients undergoing single port robotic ureterocalycostomy.
*Diabetes, coronary artery disease, history of radiation, history of Crohns disease
†Ureteropelvic junction (UPJ)
#Obstruction defined as worsening hydronephrosis or decline in split function at most recent imaging compared to pre-operative studies
^Success defined by absence of obstruction on last imaging, hardware-free at last follow-up, and without repeat surgical reconstruction
PCNT = percutaneous nephrostomy tube

(range 18-48). All patients presented with unilateral ureteral strictures – 3 each on the right and left. Two patients (33.3%) had a distal stricture in addition to the proximal obstruction, which required concomitant reconstruction with a ureteral reimplantation. Four of the patients (66.7%) had undergone prior surgical intervention with 2 having undergone prior endoscopic management and 2 prior pyeloplasty (one robotic and one open). All but one patient had a percutaneous nephrostomy tube at the time of surgery.

Median operative time was 248.5 minutes (range 172-324). One patient underwent transperitoneal reconstruction while five patients underwent a retroperitoneal approach. Three of the cases utilized an assistant port and three cases included an adjunct procedure – distal reimplants in the two cases with distal strictures and an inferior nephropexy in the third. In addition, one of the distal reimplant cases also included a proximal ventral onlay buccal graft ureteroplasty to maximize the length of healthy ureter. None of the patients underwent renal hilar cross clamping.

One patient had a urine leak requiring placement of a PCNT. Median length of stay was 1 night (range 0-2). Median length of time with ureteral stent was 4 weeks (range 2-12). At median follow up of 10.4 months (range 1.1-51.6), surgical success was 4 of 6 or 66.7% as defined by the parameters listed above. One patient continued to have obstruction, although was asymptomatic and one patient continued to require drainage via PCNT.

Discussion

The management of complex UPJO especially in patients with a history of prior pyeloplasty with inaccessible intrarenal pelvices remains a challenge. Endopyelotomy in patients with failed pyeloplasty appears to be most successful in patients with short, partial obstructions.[2,3] For longer strictures, treatment with endopyelotomy versus secondary pyeloplasty continues to be debated.[4-6]

Indications for ureterocalicostomy have traditionally been described in cases of UPJO featuring small intrarenal pelvis, a congenital anatomic anomaly, or after failed index pyeloplasty. The robotic technique was first described in 2007 by Korets et al[7] for treatment of a UPJ stricture secondary to repeated percutaneous nephrolithotomy with an atrophic lower pole and otherwise dilated calyces, a small renal pelvis, and a 1.5 cm proximal ureteral stricture. Their technique used warm ischemia during caliceal dissection with total operative time of 300 minutes. No obstruction was seen on postoperative imaging.

Subsequent case reports have modified this technique to forego cross clamping of the kidney and preoperative ureteral stent placement, opting instead to place a stent antegrade once half of the anastomosis is complete. One case emphasizes the use of nephroscopy prior to performing the anastomosis to ensure patency of the upper and middle pole infundibula. Operative time appears to decrease while outcomes remain promising.[8,9]

Our study represents the first cohort of adult patients undergoing SP RALUC primarily through a retroperitoneal approach using the Da Vinci SP Platform. A recent meta-analysis suggests that use of the SP platform for primary pyeloplasty has shorter hospital stay, less postoperative pain, and superior cosmesis with similar operative time, blood loss, complication rate, and recovery of renal function.[10] In our experience, it can be difficult to fully determine patient suitability for this approach in the preoperative setting. A relatively short, proximal ureteral/UPJ stricture in addition to intraoperative findings of a lack of a healthy renal pelvis or proximal ureter (secondary to severe scarring, for example) for a tension-free anastomosis are the primary factors which may necessitate ureterocalicostomy. In addition, dilated calyces with thin overlying parenchyma further facilitate the ability to perform a widely patent ureterocaliceal anastomosis. In the setting of longer strictures adjunct procedures can be performed concurrently such as buccal graft ureteroplasty and nephropexy as demonstrated in two of our patients. In addition to improved cosmesis, the retroperitoneal approach with SP access obviates the need to re-position the patient if endoscopic access is desired and avoids entry into the peritoneum for patients with prior intra-abdominal procedures. The flexibility of port placement is a general advantage of the SP system, allowing for selection of technique based on surgeon comfort. We show that hilar dissection and excision of the lower pole parenchyma are not mandatory, as dissection to the calyx with concomitant suture ligation of bleeding is adequate. Our intra and postoperative outcomes are comparable to both laparoscopic and multi-arm robotic approaches reported in the published literature. It is important to emphasize that while clear definitions of surgical success are necessary in the context of clinical studies, in practice significant nuance exists at the intersection of patient-reported symptoms (eg. pain), clinical presentation (eg. infection), and objective measures (eg. imaging findings and split function) which must be considered in totality when determining further workup and management options.

Conclusions

In our cohort, RALUC was utilized in patients where pyeloplasty was not possible due to severe scar of the renal pelvis or proximal ureter. When the renal pelvis is not accessible, the lower pole calyx can provide a safe location for ureteral reconstruction. □

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