Original Article

Robot-assisted laparoscopic ureteral reimplant: A single-center experience

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ABSTRACT

Introduction: Open ureteral reimplant has been the gold standard for management of lower ureteric strictures. With the widespread acceptance of robotic surgery, robotic-assisted laparoscopic ureteral reimplant (RALUR) is becoming the preferred choice for performing ureteral reimplant. We present our single-institution and single-surgeon experience of performing RALUR.

Materials and Methods: We performed a retrospective analysis of 40 patients who underwent RALUR at our institute in the last 5 years. Demographic data were recorded along with presenting complaint and diagnosis. Intraoperative variables included operative and docking time, blood loss, intraoperative complications, technique, and procedure performed. Postoperative data that were analyzed included complications, hospital stay, and outcomes. Patient satisfaction score was calculated using a numerical scale of points 1–6.

Results: The mean age of patients was 31.5 ± 9.8 years (r = 4–45). Male: female ratio was 3:5. The most common presenting symptom was flank pain, and the most common etiology was iatrogenic strictures in adults and congenital vesicoureteral reflux in children. The mean operative time and blood loss were 135.3 ± 45.1 min (r = 84–221) and 67.7 ± 31.4 ml (r = 32–118), respectively. There were no intraoperative complications and nil conversion to open surgery. The mean length of hospital stay was 4.5 ± 2.3 days (r = 3–9). Radiographic success was achieved in 41 out of 44 ureters. Eighty-five percent of the patients were completely satisfied with robotic approach and its outcomes.

Conclusion: RALUR is a minimally invasive, safe, feasible, less morbid technique with good outcome.

INTRODUCTION

Narrowing of the ureteral lumen is defined as ureteral stricture and can be congenital as well as acquired. In recent years, the extensive use of lasers and ureteroscopes and the use of laparoscopy in gynecological surgeries have led to a higher incidence of stricture formation.[1,2] The treatment of ureteral stricture disease is based on several factors, including the location, etiology, and length of the strictured segment and the function of the associated renal moiety. Traditionally, open, and endoscopic approaches for surgical repair have been employed with varying degrees of success. Laparoscopic and robot-assisted laparoscopic surgery is being increasingly used for ureteral reimplant surgery . Primary ureteral reimplantation procedure can be employed for shorter strictures of the distal ureter, whereas psoas hitch or Boari flap are used for longer strictures to overcome ureteral shortening.

Urological surgery has been particularly revolutionized by the advent of robotics where most of the reconstructive cases are amenable to the use of robotics. Hence, robotic-assisted laparoscopic ureteral reimplant (RALUR) offers the advantage of minimally invasive surgery in terms of shorter hospital stay, decreased requirement of analgesics, and better cosmesis.[3] In this study, we present our experience of RALUR.

Access this article online	
Quick Response Code:	Website: www.indianjurol.com
	DOI: 10.4103/iju.IJU_185_20

Received: 17.04.2020, **Revised:** 27.08.2020,

Accepted: 11.10.2020, **Published:** 01.01.2021

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest.

MATERIALS AND METHODS

After seeking clearance from the Institutional Ethics Committee, we retrospectively analyzed the records of the patients (n = 40) who underwent RALUR at our center between January 2015 and June 2019. A single surgeon who had a previous robotic surgery experience of 30 cases, operated all the patients. All patients who were operated were followed up for 1 month postoperatively. Only those patients who did not follow-up subsequently were excluded from the study. All patients underwent detailed evaluation including history, physical examination, cystoscopy (if indicated), routine serum biochemistry including renal function test, and appropriate diagnostic imaging such as intravenous urography, computed tomography urography (CTU), and/or magnetic resonance urography. Pediatric patients also underwent micturating cystourethrography (MCU). Patients underwent diuretic 99mTc-diethylenetriaminepentaacetic acid (DTPA) renography in cases of suspected nonfunctioning/poorly functioning kidney or to diagnose obstructed drainage. All patients provided written informed consent for the procedures, and verbal consent was sought from them while enrolling them in this study. In cases of obstructive pathology, the initial management involved urinary drainage with a ureteral stent or a percutaneous nephrostomy tube. Definitive or delayed surgical repair was usually performed 10–12 weeks later after obtaining proper informed consent.

Preoperative data such as age, gender, laterality, etiology, and preoperative presentation were recorded. Intraoperative parameters that were studied included operative and console time, blood loss, intraoperative complications, technique, and procedure performed. Postoperative data that were analyzed included postoperative complications, length of hospital stay, postoperative outcomes, and timing of double-J (DJ) stent removal. All patients were followed at least for 3 months.

During the follow-up, patients underwent renal function test, renal ultrasound, and DTPA to evaluate postoperative outcomes. Success was defined as resolution of symptoms along with resolution or improvement of radiographic obstruction and resolution or decrease in the grade of vesicoureteral reflux (VUR).

All procedures were performed transperitoneally using the robotic da Vinci system (Intuitive Surgical, Sunnyvale, CA, USA). Antegrade or retrograde ureterography was done if needed to evaluate the length of the stricture intraoperatively. A three-way Foley catheter was placed. A 12 mmHg of pneumoperitoneum was established in all patients using a Veress needle. Four ports were used, namely one port for the camera, two for the robotic arms, and one for the assistant, as shown in Figure 1.

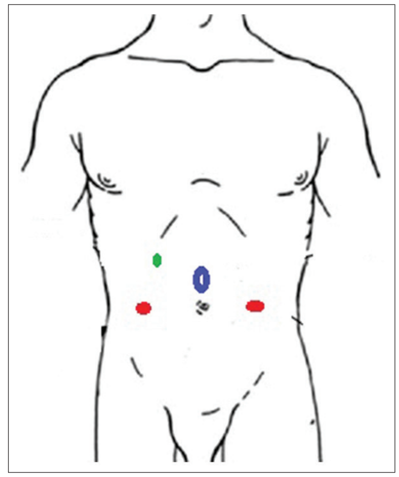

Figure 1: Port placement. Blue circle – 12 mm camera port; red circle – 8 mm robotic arms port; green circle – 10 mm assistant port

The ureter was identified at its crossing over the bifurcation of iliac vessels. Once the ureter was visualized, the ureter was dissected proximally and caudally toward the stricture. Care was taken to preserve the periureteral blood supply. The ureter was divided just proximal to the stricture. The urinary bladder was then dropped and mobilized from contralateral attachment. The lower end of the ureter was then examined to decide if a primary ureteric reimplant could be achieved without any tension or if additional maneuvers such as psoas hitch or Boari flap were needed. The method of reconstruction was decided based on intraoperative findings.

Primary ureteral reimplant

Spatulation of the distal end of the ureter was done at 6 o'clock position, followed by a 2 cm vertical incision at the anterolateral wall of the bladder. A 4-0 Vicryl absorbable suture was used for anastomosis in a continuous manner. Extravesical modified Lich-Gregoir technique was used for anastomosis. Watertight anastomosis was done over DJ stent in 2 layers, and the integrity of the anastomosis was checked by filling the bladder with normal saline for any leakage.

Ureteric reimplant with psoas hitch

Psoas hitch was used when the ureter, after resection of stricturous segment, fell short of reaching the urinary bladder to achieve tension-free anastomosis (5–10 cm defect).

The bladder was mobilized from its peritoneal attachments, and the umbilical ligaments were divided. The ipsilateral part of the dome was able to reach the level of bifurcation of iliac vessels with traction. The contralateral bladder pedicle was divided and ligated to gain additional mobility if required, and the ipsilateral bladder pedicle including the superior vesical artery was preserved; a 2.0 polydioxanone absorbable suture was used to fix the bladder wall to the psoas muscle. The rest of the technique for ureteral reimplant remained the same as described above. In our study, 10 patients required psoas hitch technique for reimplantation.

Ureteral reimplant with Boari flap

Boari flaps were used when the deficit of ureteral length is more than 10–15 cm or when ureteral mobility was restricted due to adhesions. A posterolateral bladder flap was outlined based on ipsilateral superior vesical artery or one of its branches. The flap continued obliquely across the anterior bladder wall, width at the base being at least 4 cm and at the tip being at least 3 cm. The lower end of this flap was fixed to the psoas muscle using continuous absorbable suture, and the ureter was delivered through a small opening from the upper part of the flap. Ureteral reimplant was fashioned as described previously. The flap was then closed anteriorly using a continuous 3–0 Vicryl suture.

In the postoperative period, patients were allowed gradual oral intake from day 1 onward. The abdominal drain was removed when its output was <50 ml in 24 hours. The Foley catheter was removed after 7–10 days, and DJ stent was removed approximately 4–6 weeks after the procedure. Diuretic renal nuclear scan was performed at 3 months and MCU after 3 and 6 months in cases of VUR. Additional radiographic follow-up was performed as indicated.

We assessed patient satisfaction score using a 1–6-point numerical scale regarding the entire surgical health-care experience at day 30 using the following scoring:

- 1 = Completely dissatisfied
- 2 = Moderately dissatisfied
- 3 = Slightly dissatisfied
- 4 = Slightly satisfied
- 5 = Moderately satisfied
- 6 = Completely satisfied.

The procedures adhered to the ethical guidelines of the Declaration of Helsinki and its amendments. The authors confirm the availability of, and access to, all original data reported in this study.

RESULTS

A total of 40 patients underwent RALUR between January 2015 and June 2019. The demographic and preoperative parameters of the patients are listed in Table 1. Twenty-seven patients (67.5%) underwent primary ureteroneocystostomy, while 10 (25%) patients required psoas hitch and 3 patients (7.5%) underwent Boari flap surgery. The most common indications for surgery were inflammatory ureteral strictures (following long-standing impacted stone and idiopathic) and iatrogenic strictures (post endoscopic instrumentation and secondary to injury due to previous gynecologic and pelvic surgeries). The indications in pediatric subset of patients included congenital megaureter, primary vesicoureteric reflux, and ectopic ureter. The most common presenting symptom was flank pain.

The intraoperative parameters that were studied are elaborated in Table 2. There was no conversion to open surgery in any of the cases. Early postoperative complications included increased and prolonged drain output (n = 2) which was urine in one case and lymph in other and paralytic ileus (n = 1). All of these patients responded to conservative management. The mean length of hospital stay was 4.5 ± 2.3 days (r = 3–9) as some patients were discharged with abdominal drain and/or Foley catheter.

Patients underwent DJ stent removal anytime between 4 and 6 weeks, followed by DTPA scan after 4 weeks. The mean follow-up was 16.3 months (standard deviation, 4.1). Radiographic success was achieved in 41 out of 44 ureters. Three patients reported partial obstruction with complete clearance on 24 h; all of them were kept on conservative management and follow-up. All patients with VUR had clinical improvement in terms of symptoms and resolution of recurrent urinary tract infection. Almost 85% of the patients were completely satisfied with robotic approach and its outcome [Table 3].

Table 1: Demographic profile of patients

Parameters	*n* (%)	Range
Patients		
Male	15	37.5
Female	25	62.5
Laterality		
Unilateral	36	90
Bilateral	4	10
Total ureteral reimplant	44	
Etiology		
Inflammatory	10	25
Iatrogenic	18	45
Primary VUR	4	10
Congenital obstructive megaureter	5	12.5
Ectopic ureter	3	7.5
Additional procedures		
VVF repair	4	10
UVF repair	1	2.5
Diverticulectomy	1	2.5
Age, mean±SD	31.5±9.8	4-45

VVF=Vesicovaginal fistula, UVF=Ureterovaginal fistula, SD=Standard deviation, VUR=Vesicoureteral reflux

Table 2: Intraoperative parameters

Parameter	Mean±SD	Range
Operative time (minutes)	135.3±45.1	84-221
Console time (minutes)	110±32	45-180
Docking time (minutes)	14±5	5-30
Estimated blood loss (ml)	67.7±31.4	32-118

SD=Standard deviation

Table 3: Patient satisfaction score

Patient satisfaction level	Degree	D30, *n* (%)
Completely dissatisfied	1	0 (0)
Moderately dissatisfied	2	0 (0)
Slightly dissatisfied	3	1 (2.5)
Slightly satisfied	4	1 (2.5)
Moderately satisfied	5	4 (10)
Completely satisfied	6	34 (85)

D30=Patients assessed at postoperative day 30

DISCUSSION

For ureteric reconstruction, open ureteral reimplant has been considered as the gold standard. Unfortunately, open procedure is associated with more morbidity, increased blood loss, increased analgesic requirement, slower recovery period, and poor cosmesis,[4,5] while in conventional laparoscopy, the steeper learning curve, two-dimensional (2D) vision, and difficulty in intracorporeal suturing in the pelvis are the main disadvantages, limiting its use to highly skilled experts.[6]

Robotic-assisted laparoscopic reconstruction technique provides three-dimensional (3D) visualization, precision in instrument movement, flexibility, and dexterity along with reduction in hand tremors and surgeon fatigue. It also facilitates performing intracorporeal suturing in narrow spaces. As compared to open surgery, the same standards of surgical repair can be achieved in a minimally invasive fashion with improved cosmesis and minimal morbidity. The advantages of robotic surgery have included shorter hospital stays, decreased analgesic requirement and opioid use, and better cosmesis.[7-10] In fact, the length of hospital stay (LOS) is reduced to almost half in robotic surgery as compared to open approach.[7]

Kozzin *et al*. retrospectively compared robotic-assisted ureteric reconstruction in case-controlled fashion with open ureteral reimplant technique; they observed a significant increase of estimated blood loss (EBL) and LOS in the open technique group, while the duration of surgery was longer in the robotic group, although statistically not significant.[11] Isac *et al*. compared robot-assisted with open ureteroneocystostomy (25 robotic vs. 41 open); the operative time was significantly longer in the robot-assisted reimplantation group, while EBL, LOS, and narcotic requirement were all found to be increased in the open ureteroneocystostomy group.[12] In the largest retrospective series, Fifer *et al*. have reported on the outcomes of robotic ureteral reimplant for both benign and malignant conditions. The median operative time and EBL were 233 min and 50 mL, respectively. Only 3 patients out of a total of 55 required operative intervention for a failed procedure.[13]

When comparing success rates, literature reports rates ranging from 77% to 100% for RALUR,[8,10,14-20] whereas open ureteral reimplant has success rates as high as 95%–99%.[21] There have been few comparative effectiveness studies of open versus robotic reimplantation approaches.[7,11,18,19,22-24] Success rate approaching 100% has been quoted by most of these case series with few complications reported. Similarly, three contemporary studies at moderate-to-high-volume pediatric robotic centers reported radiographic success rates of 82.4, 81.1, and 88.0%, respectively.[10,16,25] The success rate as observed in our study was 93.18% consistent with findings of other retrospective series in the literature.

While comparing the two minimally invasive techniques, Zhang *et al*. observed that the suturing time in conventional laparoscopic ureteric reimplantation was twice that of RALUR (39.59 ± 3.78 min vs. 20.04 ± 3.5 min; $P < 0.001$). Furthermore, the operative time was significantly higher in conventional laparoscopic as compared to robotic approach when it comes to ureteric reimplantation (2.44 ± 0.45 h vs. 3.09 ± 0.74 h; $P < 0.001$). The success rate of the RALUR group and the laparoscopic group was 89.3% and 82.4%, respectively ($P = 0.494$).[26] While comparing robotic and conventional laparoscopic ureteroureterostomy for ureteral stenosis, the authors concluded that robotic approach may be a better choice with shorter operative time, suturing time, and postoperative hospitalization time, although both are safe and feasible with low incidence of complications.[27]

Complications of robotic ureteral reimplantation are relatively infrequent as observed in most series, but rates as high as 10% have been reported in some series.[3,16,17] Complications include urinary tract infection, ureteral obstruction, acute renal injury, and urine leak. However, higher rates of urine leak, ureteral obstruction, and complications with higher Clavien classifications have been seen in patients undergoing RALUR.[3,8,17] Although a recent large analysis of robotic versus open ureteral reimplants revealed higher postoperative urinary complications (odds ratio = 3.1, $P = 0.02$) in robotic cases, this study did not stratify results based on laterality or type of open procedure (extravesical versus intravesical) for the comparison.[7] In our series, we did not observe any intraoperative complication, and in postoperative period also, we had a low incidence of complications, especially urinary retention. As per institutional protocol, we normally take out Foley catheter after day 6 in cases of ureteral reimplant, hence minimizing the chances of urinary retention and leak.

For any new minimally invasive technique to be acceptable, it is necessary that it should abide by the principles of open surgery and reproduce the same results as open surgery. Ureteral reimplant requires tensionless and watertight anastomosis with mucosal approximation of the viable tissues. Despite adequate preoperative antegrade imaging, retrograde imaging, and bladder capacity evaluation, defect length and anastomotic tension are most accurately assessed intraoperatively. The surgeon should be able to accomplish other surgical ancillary maneuvers such as psoas hitch or Boari flap to achieve the desired results of tensionless anastomosis. In our study, there was a change in the final management of 13 patients depending on the intraoperative findings. These patients required either psoas hitch or Boari flap to achieve tensionless anastomosis.

We tried to assess patients' satisfaction by a simple 1–6 numerical rating scale. We understand that since most patients were young and had a history of past surgery, they preferred a minimally invasive option but not at the cost of compromising success rates. Eighty-five percent of the patients reported complete satisfaction following the procedure. In a study by Barbosa *et al*., 85% of the patients preferred robot-assisted laparoscopic scares for ureteral reimplant as compared to open surgery. Scar appearance seems to be an important influence on the decision of the patient and parents of children undergoing surgery.[28]

RALUR is a safe, effective, feasible, and minimally invasive approach to deal with ureteral reimplant, but there are certain limitations for widespread use of robotic approach such as high cost of equipment and its maintenance, lack of tactile feedback, and prolonged operative time as compared to open surgery. Our study has certain limitations namely, retrospective nature, small sample size, short follow-up, and heterogeneous study population. The study clubbed both pediatric and adult populations and included mixed etiology groups requiring various other ancillary surgical procedures besides ureteral reimplant such as fistula repairs and diverticulectomy. Further randomized prospective trials are required to further validate our results and prove that RALUR is as effective as open surgery in terms of success rates.

CONCLUSION

Robotic-assisted laparoscopic ureteral reimplantation is a minimally invasive, feasible, safe, less morbid technique with good outcome and more cosmetic approach for ureteric reconstruction. Most patients are completely satisfied with this approach. Robotic surgery has a shorter learning curve as compared to conventional laparoscopy and is especially useful in pelvic reconstructive surgery with good postoperative results and minimal complications.

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How to cite this article: Tyagi V, Pahwa M, Lodha P, Mistry T, Chadha S. Robot-assisted laparoscopy ureteral reimplant: A single-center experience. Indian J Urol 2021;37:42-7.