Robotic distal ureterectomy with reimplantation in malignancy: technical nuances

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Aim: *To present the point of technique of robotic distal ureterectomy under cystoscopic guidance with pelvic lymphadenectomy (PLND), ureteral reconstruction with and without a psoas hitch in patients with distal ureteral urothelial cancer (DUCC) and to review the current literature.*

Methods: *The various steps of operative technique of robotic PLND, distal ureterectomy under cystoscopic guidance, ureteral reconstruction with and without a psoas hitch in patients of DUCC are described. Several tricks have been highlighted to undertake such procedure. The published English literature was also searched using the key words; robot, laparoscopy, ureteral reimplantation, distal ureterectomy, psoas hitch, and ureteroneocystostomy; so as to provide an up to date review on subject.*

Results: *The technique robotic pelvic lymphadenectomy, distal ureterectomy, ureteral reimplantation with and without a psoas hitch in patients with DUCC was successful in both our patients. The mean operating room time, robotic (console) time, mean estimated blood loss and mean hospital stay were 250 min, 130 min, 150 cc and 2.2 days respectively. There were no complications.*

Conclusions: *The technique of robotic distal ureterectomy with ureteral reimplant for malignant ureteral strictures continues to be in evolution. Surgeon should be versatile with various options and technical nuances while dealing with these cases. The short term oncologic outcomes appear to be satisfactory and encouraging, while the long term results are awaited.*

Key Words: robot, laparoscopy, ureter, ureteral tumor, lymphadenectomy, distal ureterectomy, psoas hitch, ureteroneocystostomy

Introduction

The surgical management of distal ureteric strictures (benign or malignant) is a challenging task. Distal ureterectomy is the management of choice for localized malignant distal ureteral tumors or strictures at large volume centers in experienced hands. Laparoscopy has emerged as a new basic standard of care in several areas of urologic surgery; this has compelled many urologists to treat these lesions in a minimally invasive way. Robotic assistance helps in challenges associated with pure laparoscopic distal ureterectomy and complex lower ureteral reconstructions (tension free ureteral reimplantation with or without a psoas hitch, Boari flap or ileal ureter) in addition to pelvic lymph node dissection in neoplastic ureteral lesions.

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Case one

A 78-year-old Caucasian male was referred to our center with a history of gross total painless intermittent hematuria for the past 2 months due to a distal right ureteral tumor. He was also being treated for coexistent cancer prostate (Gleason 3 + 3 = 6) by androgen deprivation therapy. A computed tomography (CT) of his abdomen and pelvis revealed an avidly enhancing lesion at right ureterovesical junction with hydroureter, pyelocaliectasis and pelvic lymphadenopathy. The CT did not suggest any evidence of tumor proximal to the distal right ureter. Retrograde pyelography of the right side, revealed a large multilobular filling defect in the distal right ureter (with goblet sign appearance) extending to right ureterovesical junction. No passage of any contrast was observed proximal to the mass in the distal right ureter, the left ureter and the left intrarenal collecting system was normal. Ureteroscopy was performed with a semi rigid ureteroscope which revealed a ureteral mass at about 2 cm-3 cm from the right ureteric orifice, for which multiple tumor brush biopsies were taken. Histopathology confirmed a papillary lesion suggestive of low grade TCC. After extensive counseling, the patient elected for a robotic-assisted laparoscopic PLND, distal ureterectomy with ureteric reimplantation. Pneumoperitoneum was established with a Veress needle to insufflate to 14 mm Hg and a 12 mm port was inserted in to the periumbilical area to accommodate for the laparoscope mounted with a stereoscopic camera. The 8 mm robotic ports were inserted about three inches below the umbilical port to right and left side of lateral rectus muscle. A 5 mm port was inserted in to the right flank area an inch above iliac crest and a 5 mm port was inserted between the right robotic arm and the camera port. The robot was then docked. During the port insertion the right port was placed more lateral than usual (about 2 cm lateral to the lateral border of the right rectus muscle) and the left port was more medial than usual (about 2 cm medial to the left rectus muscle) for a right distal ureterectomy so as to triangulate all the three ports in to the area of surgical dissection being focused with minimal instrument collision. After an initial thorough peritoneoscopy, sigmoid vesicle adhesions (subclinical diverticulitis) were taken down sharply. An extended bilateral pelvic lymph node dissection was performed (laterally extending up to the genitofemoral nerve, medially up to the obturator nerve and vessels and extending inferiorly up to the iliacus muscle; proximally up to the level of the aortic bifurcation and ipsilaterally to the level of node of Cloquet distally) in a standard fashion as previously described by us.[1]

The right distal ureterectomy was initiated by identifying the ureter as it crossed over the right iliac vessel. The dissection was then carried distally and the right medial umbilical ligament (superior vesicular artery) was doubly clipped and cut. Dissection was then carried down to the level of the right ureterovesical junction. The tumor was identified as a bulge in the right distal ureter seen at about 2 cm proximal to the entry of the ureter into the bladder, Figure 1. Sterile distilled water was instilled in to the bladder in order to distend it, which helps in its identification intraperitoneally and this also help in lysis of tumor cell(s). At this point, the ureter was clipped proximal to the ureteric tumor to prevent tumor spillage proximally during handling of the ureter. Next the distal ureter was also similarly clipped, as it was possible. The ureterovesical junction and bladder was mobilized circumferentially about 2 cm beyond the right ureterovesical junction. Once we were ready to excise the ureterovesical junction and the bladder cuff, simultaneous flexible cystoscopy was performed and under direct cystoscopic vision; and an enbloc excision of bladder cuff about 2 cm beyond the right ureterovesical junction was accomplished. The proximal ureteric and bladder edge frozen biopsy were obtained to confirm negative intraoperative surgical margins.

Ureteroneocystostomy was performed by approximating the ureter with the bladder using 5-0 Monocryl running suture in two hemi circles in a tension free manner. After completing one side hemicircle of ureterovesical sutures, pure robotic retrograde ureteral stenting was performed by

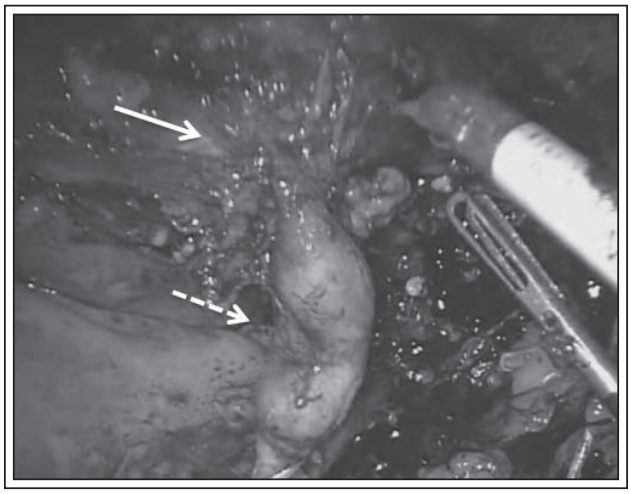

Figure 1. Panel figures demonstrating the technique of robot-assisted distal ureterectomy. A robotic endoscopic view with a dotted white arrow (→) showing the dissected ureteric tumor and a bold white arrow (→) showing the ureterovesical junction.

inserting a previously set up (clipped on a guide wire) 8.2 F x 26 cm JJ stent. The bladder was then inflated with 250 cc of saline to rule out an anastomotic leak. The 8 mm and 12 mm port sites were closed using #1 Vicryl suture and a Carter Thomason closure device. After the robot was dedocked, the skin was closed using #4-0 Monocryl in a subcuticular running fashion. The patient recovered uneventfully. The estimated blood loss (EBL) was 100 ml and the total operative time was 4 hours inclusive of a console time of 2 hours. The histopathology turned out right ureteral low grade papillary urothelial carcinoma with invasion of lamina propria (excluding muscularis propria), and the bladder/distal ureteral margins were free of tumor, without any vascular invasion. All the seventeen pelvic lymph nodes removed were negative for tumor. The JJ ureteral stent was removed uneventfully 4 weeks later. He is doing well at a further follow up of 2 months.

Case two

A 58-year-old white male presented with gross painless hematuria of 2 years duration. He had a past history of graveluria and SWL. His general and local clinical evaluation was unremarkable. His rectal examination revealed grade 1 normal prostate.

Cystoscopy revealed blood originating from the left ureteral orifice. Patient underwent retrograde pyelography (RGP) which demonstrated a left distal ureteral stricture, and left ureteral brush biopsy and left urine cytology turned out to be positive for urothelial carcinoma. After a detailed counseling the patient elected for a robot assisted PLND, distal left ureterectomy with psoas hitch and a possible Boari flap.

Under general anesthesia, low Trendelenberg position, a pneumoperitoneum was established and ports were placed in similar manner as in Case 1. The operative steps were same as in Case 1 except a robotic psoas hitch, Figure 2a, was performed by first dissecting and clearing the space over the psoas muscle and then applying three 1-0 PDS sutures placed 1 cm-2 cm apart to tack the bladder with the psoas muscle, (taking care to identify and preserve the genitofemoral nerve). A tension releasing suture was applied to fix the periureteral tissue with the psoas muscle. With the bladder dome open the ureterovesical anastomosis was performed with an interrupted 5-0 monocryl suture, over a 6 F / 26 cm JJ ureteral stent, Figure 2b. Cystotomy was closed with a #1-0 Vicryl suture. The procedure was terminated by placing a 14-French Blake drain through the left sided 5 mm port and rest of the ports were closed as described in previous case.

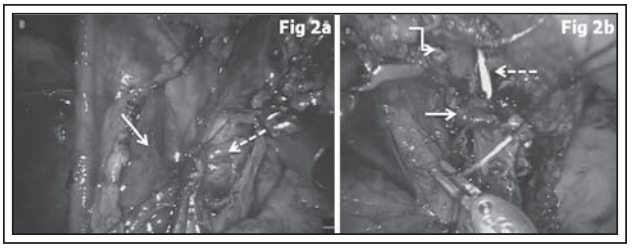

Figure 2. Panel figures depicting the technique of robot assisted ureteroneocystostomy.
A robotic endoscopic view showing the placement of a psoas hitch sutures, with a bold white arrow (→) depicting the dissected psoas muscle and a dotted white arrow (→) depicting the bladder margin, see panel figure (2a); Robotic endoscopic view of the ureteroneocystostomy anastomosis in progress with a bold white arrow (→) depicting the distal ureteral margin, a dotted white arrow showing (→) the JJ ureteral stent in situ and a ↳ arrow depicting the vesical margin, see panel figure (2b).

The procedure was successfully accomplished with an estimated blood loss of 150 ml, with a total operating time of 4 hours and twenty minutes inclusive of a console time of 2 hours and twenty minutes, without any complications. The patient recovered uneventfully and was discharged on the third postoperative day. The Foley urethral catheter was removed on the seventh day after a check cystogram confirming no leak. Final histopathology confirmed left ureteral noninvasive urothelial carcinoma with negative distal ureteral and bladder margins. A total of nineteen pelvic lymph nodes removed were all negative for cancer. His JJ stent was removed uneventfully 4 weeks later. He is doing well on a further follow up of 3 months.

Discussion

Laparoscopic ureteroneocystostomy (LNC) or ureteral reimplantation is a technically demanding laparoscopic reconstructive procedure.[2] LNC was initially described in a pediatric patient by Ehrlich and coworkers,[3] but the first adult LNC was described and later published by Reddy and Evans.[4] Yohannes and colleagues first published the technique of robotic-assisted LNC (refluxing) for distal ureteral strictures.[5] The first laparoscopic nonrefluxing UNC with a psoas hitch is credited to Chung and colleagues in 2006[6] who first described the laparoscopic technique of constructing a submucosal tunnel.

With the advent of the daVinci (Intuitive Surgical, Mountain View, CA) surgical robotic system and its

TABLE 1. **Salient features of robotic assisted ureteral excision and reconstruction**

Author	No.	Diagnosis	Technique	Periop parameters	Complications
Johannes, 2003	01	Distal ureteral stricture	5 ports, refluxing UNC	ORT-210 min EBL-< 50 ml HS-5 days	Nil
Mufarrij, 2007	04	Distal ureteral stricture, acquired gynecological in (3), congenital(1)	4 ports, psoas hitch, extravesical refluxing UNC	ORT-240 min EBL-35 HS-3.5 days	2007 Nil
Naeyer, 2007	01	Distal ureteral stenosis (endometriosis)	4 ports, non-refluxing-UNC, interrupted sutures	ORT- 20 min EBL-negligible HS-7 days	Nil
Patil, 2008 (Multicentre study)	12	Ureteral stricture (10), ureterovaginal fistula (1)	Robot-assisted UR with psoas hitch (12)	ORT-208 (80-360) Console time-173 (75-300) EBL-48 (45-100) HS-4.3 (2-8)	Nil (Av FU 15.5 mth)
Laungani, 2008	03	Ureterovaginal fistula	6 ports, spatulated UNC continuous suturing	Console time-100.3 (62-118) EBL-72.6 ml (52-102) HS-1.2 d	Nil
Casale, 2008	41	Pediatric bilateral VUR	Lap transvesical Ur reimplant + robot	Av ORT-2.33 hr Av HS-26.1 hr	97.6% success rt No complications
Schimpf, 2008	01	Benign ureteral stricture	Robotic Boari flap + reimplant	ORT----- EBL-100 ml HS-2.5 days	---
Gilianski, 2008	09	Distal ureter TCC	Rob distal ureterectomy with bladder cuff excision, psoas hitch in (6), IVUR(1)-EVUR(5)	ORT-252 min EBL-44 ml HS-1.5 days	CR-1 (11.1%- ureteral stricture)
Present	02	Distal ureter TCC	Rob distal ureterectomy with bladder cuff excision, psoas hitch (1), b/l Plnd, interrupted UNC, EVUR(3)	Mean ORT-250 min Mean console time-130 min EBL-125 ml HS-2.25 days	Nil

VUR = vesicoureteral reflux; IVUR = intravesical ureteral reimplant; EVUR = extravesical ureteral reimplant; CR = complication rate

concomitant success in performing ablative (radical prostatectomy, cystectomy) and reconstructive urological procedures such as pyeloplasty, urologists began exploring it's feasibility and efficacy in performing lower urinary tract reconstructive procedures (ureteral reimplantation). The first pure robot assisted ureteral reimplantation with a psoas hitch was successfully reported in 2007 by Naeyer and coworkers in a patient with distal ureteral stenosis caused by endometriosis,[7] they concluded that robot-assisted reimplantation could be performed with greater ease and technical precision than by the conventional laparoscopic technique. Later in the same year Mufarriz and colleagues also reported the robotic technique of extravesical ureteral reimplantation in four of their patients with distal ureteral stricture incorporating a psoas hitch in all their patients.[8] Later Patil and coworkers also reported a series of 12 cases

of robotic ureteral reimplantation for benign ureteral strictures.[9] Glinianski and coworkers also recently reported their successful experience with a robotic distal ureterectomy for distal ureteral TCC in nine of their patients with the need for a psoas hitch in six of them during a ureterovesical reimplant.[10] For high ureteral stricture transection where the ureter-bladder gap approaches or exceeds 10 cm-15 cm others have also described laparoscopic[11] and robotically assisted Boari's flaps[12] in conjunction with a robotic UNC.

In our present series of two cases of distal ureteral urothelial cancer (malignant ureteral stricture) we have described the purely robotic technique of distal ureterectomy with bilateral pelvic lymphadenectomy and ureteroneocystostomy along with a robotic psoas hitch in one of the patients, which has been rarely reported and described in the published English literature.[8-10] Table 1 shows the salient features with a review of cases of robotically assisted ureteral reimplantation/s described and reported by others.

Certain steps deemed necessary by us towards enabling a successful robotic distal ureterectomy and reimplantation are:

(i) A 30-45 degree head down tilt and a slight upward tilt on the side of the ureteral dissection is quite helpful;
(ii) A liberal dissection of the distal ureter from the surrounding tissues;
(iii) Clipping the ureter proximal and distal to tumor (if feasible) in order to prevent spillage of urine and tumor cells;
(iv) Instilling sterile water in to the bladder prior to cystotomy aids in its intraperitoneal identification, and helps in scoring the bladder cuff;
(v) Simultaneous retrograde flexible cystoscopy with a cut to light approach enables a precise cystotomy so as to meticulously encompass and excise the distal ureter and bladder cuff enbloc, taking care of the contra-lateral ureteral orifice;
(vi) Bilateral standard pelvic lymphadenectomy;
(vii) Frozen sections from the distal ureteral margin and proximal bladder cuff margin prior to UNC; (viii) If tension free UNC can not be achieved then we use psoas hitch sutures prior to a stented UNC;
(ix) Placement of a bladder holding /traction suture to facilitate initiation of an ureteroneocystostomy;
(x) Closure of bladder and detrusorraphy are performed, whenever a psoas hitch is required as an adjunct to UNC; and
(xi) Placement of perivesical and peri ureteral sutures after completion of the stented ureterovesical anastomosis in order to release the tension and minimize the chances of urinoma. In a high ureteral excision a Boari's flap often needs to be fashioned to bridge the gap between ureter and bladder.

The worldwide experience with robotic ureteral reimplantation with or without a psoas hitch[6,8] or Boari's flap[11] for distal ureteral stricture is limited.[6-13] Uberoi and colleagues[11] also described a combined endoscopic and robotic approach to distal ureterectomy, they however used a Collin's knife to score out the bladder cuff endoscopically prior to the robotic ureteral dissection. Casale and colleagues also successfully described their technique of nerve sparing transperitoneal robotic extravesical ureteral reimplantation for correction of vesicoureteral reflux, however their study focused only on the pediatric population.[12] They concluded that the use of the robot was associated with better visualization that facilitated early detection and preservation of the pelvic nerves.

The robotic technique of distal ureterectomy with reconstruction (with of without a psoas hitch) for malignant ureteral strictures as described and reported by us is technically safe, and is oncologically feasible. It is also capable of preserving the advantages of minimally invasive surgery, with acceptable early outcomes. Robotic-assisted surgery has the distinct advantage of three dimensional enhanced magnification, motion scaling and ability to perform endo wristed intuitive movements with seven degrees of freedom that facilitate robotic ureterectomy, pelvic lymphadenectomy, ureteral reimplantation with and without a psoas hitch or a Boari flap. □

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EDITORIAL COMMENT

The authors have done a nice job of presenting the technical feasibility of ureteral reimplantation with robotic assistance adding to the existing sparse literature. Having performed 12 robotic ureter reimplantation procedures (primary reimplantation, psoas hitch, Boari flap) for stricture disease not related to cancer, I am convinced that in experienced hands, this minimally invasive approach provides an excellent alternative to open surgery. However, I have several reservations as regards to performing such procedures for ureteral malignancy. First, there is concern for transperitoneal seeding of cancer when opening the bladder via a transperitoneal approach. This theoretical risk may be magnified with simultaneous cystoscopy (as described in the manuscript) with the inherent use of bladder irrigation. Seeding risks may be decreased via an extraperitoneal approach. It is imperative that the operative surgeon rule out concomitant bladder malignancy (carcinoma in situ or papillary disease) in advance of the ureteral reimplantation procedure. Second, in cases where near complete distal ureteral obstruction prevents the passage of a ureteroscope, a more proximally located tumor not seen on cross sectional imaging may serve as a nidus for transperitoneal seeding during the procedure. Finally, in cases of non-bulky long segment malignancy (unlike Figure 1 in the manuscript), judging the precise proximal and or distal ends of malignancy may be challenging. Some surgeons have proposed the use of Fogarty balloons placed via cystoscopy/fluoroscopy at the outset of the case to aid in identification of the malignant section of ureter. But slight manipulations during patient positioning may make this technique imprecise. Such cases may be the rare instance where hand palpation provides additional clues beyond the visual ones provided by the minimally invasive approach. With less than 20 published cases of robotic ureteral reimplantation for transitional cell cancer and a short follow up, at this time, I am hesitant to recommend robotic or laparoscopic ureteral reimplantation in cases of distal ureteral malignancy.

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REPLY BY AUTHORS

We appreciate the thoughtful commentary by Dr. Moinzadeh and as urologic oncologists we share many of his concerns. First, there is a theoretical risk of tumor seeding which has not been borne out by the long term data of nephroureterectomy which do not demonstrate increased local recurrence rates or issues surrounding peritoneal seeding and is considered by some as an emerging gold standard for management of upper tract TCC.[1,2] Additional methods employed in the above cases included hemo-lock clipping above and below the lesion when possible and the use of stay sutures above and below the ureter to prior to cystotomy to allow for rapid bladder closure and minimize tumor spillage. Second, we agree that further upper tract lesions need to be ruled out either by delayed contrast CT or MRI or by direct inspection through ureteroscopy, the ureter proximal to the disease in question was deemed to be free of tumor by both contrast imaging and direct inspection prior to proceeding. Finally, it can be challenging to identify the proximal extent of some lesions. Therefore, careful preoperative planning and frozen sections of the proximal margin are essential adjuncts to this approach.

Fortunately the risk of tumor implantation for low grade urothelial cancers may be theoretical and not so significant so as to deny patients the benefits of minimally invasive robot-assisted laparoscopic surgery. While long term data is awaited, the technique of robot-assisted laparoscopic distal ureterectomy continues to evolve and the initial oncological outcomes, so far appear to be encouraging.[3]

We applaud the cautious optimism by Dr. Moinzadeh and others when viewing newer techniques of treating a potentially lethal disease. We feel strongly however, that when performed on properly selected patients with adequately trained surgeons, that this is an oncologically sound procedure that provides patients with the best possible outcomes with the least amount of morbidity and look forward to this procedure playing an increasingly important role for the small number of patients in whom it is indicated.

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