



Robotic radical cystectomy with intracorporeal urinary diversion: beyond the initial experience

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Abstract: Robotic assisted radical cystectomy (RARC) has gained popularity within minimally-invasive urologic surgery, and has been shown to be a safe procedure with similar oncologic outcomes when compared to the conventional open standard. While initial RARC feasibility and outcomes studies were performed with extracorporeal urinary diversion, intracorporeal urinary diversion (ICUD) is becoming increasingly utilized. Reported benefits of an intracorporeal approach include decreased blood loss and a lower incidence of ureteral strictures. While ICUD is technically challenging, many have overcome the learning curve associated with this procedure via a mentorship model and a dedicated operative team. Techniques vary between institutions, and ileal conduit, continent cutaneous and orthotopic continent (neobladder) diversions have all been performed. Herein, we describe the learning curve, technical points, and unique complications associated with ICUD.

Keywords: Minimally-invasive surgery; bladder cancer; intracorporeal; urinary diversion

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Introduction

Robotic assisted radical cystectomy (RARC) is an established and safe procedure within minimally invasive urologic oncology (1). Multiple studies, including prospective randomized clinical trials, have demonstrated similar oncologic outcomes and complication rates when comparing RARC to conventional open radical cystectomy (ORC) (2-6). More recently, the RAZOR trial, a randomized, open label phase-3 non inferiority study, demonstrated that RARC was non inferior to ORC with regards to 2-year progression free survival (7). Of note, all of the patients in these trials had an extracorporeal urinary diversion (ECUD). Completely intracorporeal urinary diversion (ICUD) was first described in 2003 (8). Though ICUD was initially performed in only 9% of cases in 2005, the most recent update by the International Robotic Cystectomy Consortium (IRCC) reports an increase to

97% in 2015 among their group (9). While a prospective randomized controlled trial comparing RARC with ICUD to ORC is enrolling, long-term outcomes following ICUD appear similar to historic open cohorts (4,10-12).

Reported benefits of ICUD have included decreased evaporative fluid losses and blood loss with faster return of bowel function and shorter hospital stays (13-15). However, ICUD poses its own challenges within the context of an already demanding, extirpative procedure. Herein, we describe the learning curve, technical points, and unique complications associated with ICUD.

Learning curve

Each surgical procedure has its own learning curve, and much of the trepidation in adoption of ICUD is derived from concerns regarding technical proficiency

and perioperative morbidity; this is particularly true with intracorporeal orthotopic continent diversion (9,16). In 2010, the IRCC sought to define technical parameters for RARC, at which time the majority were performed with ECUD (17). Hayn and colleagues reported that 21 cases were needed to obtain operative times less than 6.5 hours and 30 cases were needed to obtain a lymph node yield of 20. Most importantly, they demonstrated that 30 cases were required to have an overall positive surgical margin rate of 5% or lower (17).

The most recent assessment by the IRCC revealed that in 2016, 81% of all urinary diversions in RARC are intracorporeal ileal conduits (IIC). Intracorporeal neobladder (IN) represented 17% of all diversions (9). In their report of transition from EC—ileal conduit to IIC (68 *vs.* 59 patients, respectively), Tan *et al.* noted shorter total operative times, blood loss and 30-day overall complication rate in the ICUD cohort (15). Moreover, they had noted a shorter total operative (300 *vs.* 360 min) in their last 29 ICUD cases compared to their first 30. Similar findings with respect to operative times and complication rate were reported by Porreca *et al.* in a retrospective analysis of the first 100 ICUD performed after completion of a strict, modular training program; ICUD included ileal conduit, orthotopic neobladder, and cutaneous ureterostomy (18).

Collins *et al.* prospectively evaluated the learning curve on the first 67 RARC with IN at their institution amongst two surgeons (14). In having to navigate the learning curve individually without the assistance of a more experienced surgeon, the “mentor” surgeon had significant improvements in operative time and overall complication rates amongst 47 patients. The “mentee” surgeon did not have statistically significant improvements in these parameters, though operative times did trend downwards. There were no differences in outcomes between the two surgeons apart from an average lower blood loss in the “mentee” (613 *vs.* 462 mL), which may be explained by higher blood loss in earlier cases performed by the “mentor.” This suggests that the learning curve of intracorporeal diversion can be abbreviated by the “mentee” working closely with a surgeon who has already overcome it and achieved mastery. In addition, the familiarity of the operative team with the procedure and ability to troubleshoot and bedside assist improves with each case. This mentorship practice model may facilitate bringing the reported advantages of ICUD to a larger population of patients.

At our institution, the mentor surgeon proctors up to the initial 50 cases depending on the mentee’s prior

robotics experience. In addition, RARC with ICUD are often performed on the same day by the mentor and mentee surgeons in adjacent operating rooms to facilitate communication and operative assistance. The mentor surgeon is also notified and available for particularly challenging cases, such as in the post-radiation setting. There is a group scrub of nurses and technicians that participate almost exclusively in robotic cases. Laparoscopic assistance for the procedure is provided by a rotating cohort of junior residents and urologic oncology and minimally invasive surgery fellows.

The learning curve, in reality, likely extends beyond the initial estimates of approximately 30 cases. The IRCC has reported outcomes of 1094 ICUD over a 10-year period (9). They found that high grade complications in ICUD decreased significantly from 25% in 2005 to 6% in 2015, while a similar decrease in complications was not identified (13% in 2006 to 14% in 2015) in the ECUD cohort. The consortium also demonstrated shorter operative times with ICUD compared to ECUD, as well as lower blood loss.

A dedicated care pathway can also improve convalescence. Tan *et al.* evaluated the role of an enhanced recovery after surgery (ERAS) pathway in their transition from ORC, to RARC-ICUD without an ERAS protocol, and subsequently RARC-ICUD with an ERAS protocol (19). Despite having a higher American Society of Anesthesiologists score, the ERAS cohort had a significantly shorter median length of stay compared to the RARC non-ERAS group and the ORC group (7 *vs.* 11 *vs.* 17 days, respectively). The ERAS group also had significantly lower 90-day readmission rates.

Clearly, a committed effort to performing ICUD will allow the learning curve to be overcome, as has been demonstrated with robotic prostatectomy and robotic partial nephrectomy (20). Given the potential advantages when compared to ECUD or traditional ORC, initial trepidation regarding proficiency should not preclude its uptake.

Technical points

Port placement

The success of ICUD is predicated on adhering to the principles of open surgery, particularly for orthotopic ICUD; several authors have described their techniques (16,21-23). When compared to robotic prostatectomy, the ports in RARC are placed more cephalad to allow for extended pelvic lymph node dissection (LND), and manipulation of the afferent/proximal bowel limb for diversion (1,24). At our institution, we favor placing ports

in a “W” configuration. This consists of a midline 12 mm camera port placed 5 cm cranial to the umbilicus, three 8mm robotic ports, and a 12 mm assistant port, usually as the right most port (24). Per surgeon preference, an additional 12 mm suprapubic assistant port can be placed to facilitate bowel reconstitution during ICUD. Of note, an emphasis on cephalad and medial placement of the right robotic port is critical to facilitate ICUD. The Karolinska group similarly places the camera port, though the remaining ports are positioned at the level of the umbilicus (1,25). The City of Hope group places ports 20 or 23 cm from the pubic symphysis, with an additional subcostal assistant port contralateral to the 4th robotic arm (1,21). In addition, robotic port configuration has been described for both the DaVinci Si and Xi robotic platforms (Intuitive Surgical, Sunnyvale, CA) by Pathak *et al.* and the Wake Forest group (26). Of note, they report that placing an additional 12 mm assistant port close to the midline facilitates bladder pedicle takedown during the extirpative component of the cystectomy. The group also describes supine side-docking of the Xi robot as opposed to positioning between the legs in Trendelenburg, which can eliminate risks of ophthalmic, pulmonary and positional nerve injury. Moreover, the use of the TruSystem™ OR Table (Trumpf Medical, Saalfeld, Germany) allows for position changes without the need to re-dock if a hybrid approach is used.

IIC

Our group is able to perform IIC with a standard 5 port configuration. After the extirpative component of the procedure, the left ureter is brought under the sigmoid colon mesentery. Stay stitches are placed on the proximal and distal segments of a 15 cm segment of ileum 15cm proximal to the ileocecal valve. An avascular segment of the mesentery is taken down at the proximal and distal aspect, and a 60 mm load of the Endo-GIA stapler (Covidien, Dublin, Ireland) is inserted through the 12 mm right most assistant port to divide the ileal loop. We then reconstitute the bowel prior to the uretero-ileal anastomosis (UIA). After ensuring proper orientation with the use of stay stitches, two 60 mm Endo-GIA staple loads are used to complete the side-to-side anastomosis. One staple load is used for the transverse component. The UIA are performed in Bricker fashion with two running 4-0 Vicryl sutures (Ethicon, Summerville, USA) beginning at the apex of the spatulated ureter. 8 Fr × 30 cm double J ureteral stents are placed

directly into the ureter half-way through each anastomosis. Once they have reached the upper tract, the distal coil is then positioned within the conduit, and the anastomosis is completed. The stents are not externalized. The stoma is then matured after specimen extraction.

The Roswell Park group has previously described the “Marionette” technique for IIC (23,27). Key differences in their approach are as follows. Initially, a silk stay stitch is passed through the abdominal wall, inferior to the site of the future stoma, through the distal end of the conduit and back through the abdominal wall. This stitch is not tied, rather it is manipulated by the instrument arm like a “marionette” throughout the remainder of the procedure. Ileal loop isolation is performed similar to our technique, though bowel reconstitution is performed after the UIA. A Bricker UIA is performed. Stent placement is facilitated through a suction tip, which is passed via the assistant port through a distal enterotomy. It is maneuvered through conduit to the site of the UIA. Single-J ureteral stents are then placed via the suction tube, sutured into position, and the suction tip is subsequently removed. Bowel continuity is then re-established through the placement of an additional suprapubic port. The stoma is then matured.

Intracorporeal continent cutaneous diversion—Indiana pouch

Desai *et al.* have reported on a series of 10 patients undergoing continent cutaneous (Indiana Pouch) ICUD and discuss several components unique to this form of diversion (28). Mainly, working on the right colon requires the addition of three ports and upsizing another, along with undocking and redocking the robot. If utilizing the DaVinci Si console (Sunnyvale, USA), the patient must also be repositioned to the right side up position, which can be avoided with the DaVinci Xi. Their oncologic outcomes and complication rates were similar to that reported in other RARC literature, but they do recommend other ICUD experience prior to undertaking Indiana Pouch formation. Moreover, they suggested that surmounting the learning curve may be more challenging than other ICUD given that Indiana Pouch formation is a less common type of diversion.

IN

A variety of techniques have been used to describe IN (1,16,25,29). Using the Idea, Development, Exploration, Assessment, Long-term follow-up (IDEAL) Collaboration guidelines, the University of Florence group reported on

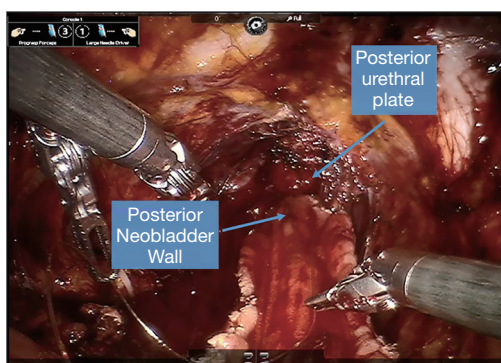


Figure 1 Anchoring and tensioning the posterior neobladder wall to the posterior urethral plate after bowel detubularization.

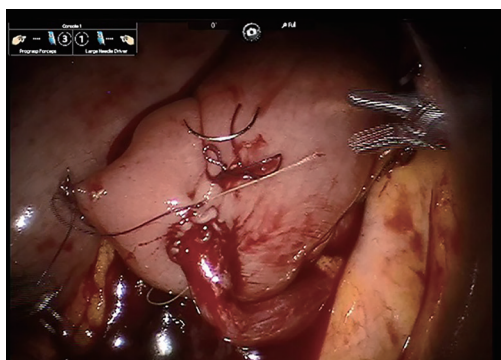


Figure 2 Completion of the right ureteroileal anastomosis in Bricker fashion; the left ureteroileal anastomosis was performed on the contralateral aspect of the afferent limb and is currently hidden.

a series of 18 patients with an emphasis on reconstruction of a “neo-trigone” with “orthotopic” UIA (29). After isolation of a 50 cm ileal loop, the urethroileal anastomosis is performed, leaving 20 cm of bowel proximal and 30cm distal to the anastomosis resulting in an asymmetric U. The ileum is then detubularized and the posterior plate is reconfigured as an “L”, effectively creating an orthotopic neo-trigone. The bladder neck is reconfigured anteriorly and the posterior plate is then folded anteriorly to close the defect. The ureters are then spatulated and re-anastomosed at the neo-trigone in Bricker fashion. Of note, this neobladder does not contain an afferent limb.

The Karolinska group also favors performing the urethroileal anastomosis prior to bowel isolation and reconstitution (1,25). The dependent portion of 50 cm of ileum is isolated, of which the distal 40 cm is detubularized. They also perform rotation and double folding to obtain a

more spherical reservoir, and do leave a 10 cm aperistaltic afferent limb upon which the ureters are anastomosed in Wallace fashion.

The USC group first isolates approximately 60 cm loop of ileum, of which the proximal 15 cm becomes the afferent limb (16,21). The distal ileum is then detubularized. The posterior plate is reconstructed and then rotated 90 degrees counter clockwise prior to performing the urethroileal anastomosis at the midpoint of the distal, rotated edge. The anterior closure is then performed by cross-folding, and the ureteroileal anastomosis is performed in Bricker fashion.

Obtaining a tension free urethroileal anastomosis can be among the most challenging components of IN. We have described several maneuvers to facilitate completion of this step, apart from careful ileal loop selection (24). This includes, in a step-wise approach, the following: maximizing urethral length at the prostatic apex, removing the sigmoid colon out of the pelvis after the extirpative portion of the procedure, reduction of pneumoperitoneum and decreasing steep Trendelenburg, application of perineal pressure, utilizing barbed suture and detubularizing the ileal loop closer to the mesentery to lengthen the posterior plate. As a last resort, incising the mesentery and releasing the mesenteric fat can produce additional length. Of note, we previously performed our urethroileal anastomosis prior to loop detubularization, but now favor anchoring the posterior bowel/neobladder wall to the posterior urethral plate as seen in *Figure 1*. This modification was made as we found that it was easier to tension the initial urethroileal anastomotic sutures. *Figure 2* demonstrates the Bricker ureteroileal anastomosis. *Figure 3* displays anchoring of the suprapubic catheter after completion of the urethral anastomosis, closure of the anterior neobladder wall and ureteroileal anastomosis completion.

Image guided surgery

The use of indocyanine green can facilitate many components of RARC and ICUD including tumor identification, sentinel lymph node drainage, mesenteric angiography during bowel transection and reconstitution, aid left ureteral tunneling under the sigmoid mesentery, identifying ischemic ureteric segments during anastomosis and verifying non-ischemic enteroenteric anastomosis (30,31). Manny and Hemal reported on a series of 10 patients undergoing fluorescence-enhanced RARC, of which 8 underwent IIC. Mesenteric angiography with identification of bowel arcades prior to bowel stapling was successful in all 8 of the patients undergoing IIC, with vascular identification occurring

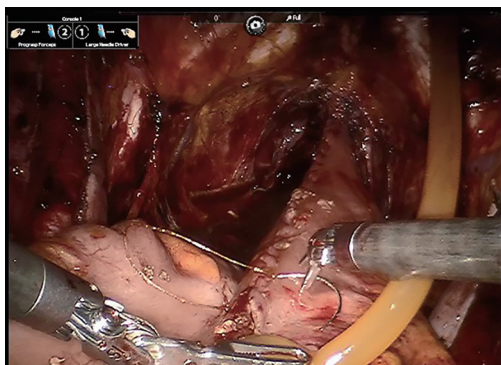


Figure 3 Anchoring the suprapubic catheter after completion of the urethral anastomosis, closure of the anterior neobladder wall and completion of bilateral ureteroileal anastomoses.

at a median time of less than 1 min (30). No short term complications relating to anastomotic stricture or stomal stenosis were noted in short term follow up.

Surgery related complications

Radical cystectomy remains among the more morbid procedures in urology due to the risk factors for bladder cancer and the resulting patient comorbidities, as well as the extent of surgery with a urinary diversion (32).

Novara *et al.* have performed a systematic review and meta-analyses of RARC with ICUD and ECUD (33). In the subset analysis of ICUD, the overall 30 day complication rate was 67% (range, 42–86%) for ileal conduit and 46% (range, 43–62%) for neobladder with high grade complication rates of 24% (range, 0–54%) and 28% (15–33%), respectively (33). Mortality rates ranged from 0–3% across ICUD.

LND can confer a survival benefit in patients with bladder cancer, and while the optimum extent of dissection is still debated, its diagnostic and prognostic value is not (34,35). LND, however, is not without morbidity. In their analysis of ICUD, Schumacher *et al.* detected a 12% 30 day complication incidence related to LND (36). Of the 5 patients with LND related complications, 3 developed a lymphocele, 1 developed iliac vessel bleeding, and another had deep venous thrombus formation.

A theoretical advantage of ICUD is a decreased risk of distal ureteral ischemia and subsequent ureteral leak or stricture given the shorter length of ureter required when compared to ECUD or ORC. The reported benign anastomotic stricture rate in large ORC series is between

3–10% (37,38). Anderson *et al.* (39) compared ORC to RARC-ECUD and noted a stricture rate of 8.5 *vs.* 12.6%, respectively ($P=0.2$). It seems appropriate that the stricture rate would be similar, given that the ureteral length required for the diversion is similar in both arms. In comparison, review of series of ICUD with a minimum of 100 patients demonstrate a UIA stricture or leak rate ranging from 2–3.8% (16,23,32). Schumacher *et al.* reported 2 UIA strictures (4.4%) successfully managed with balloon dilation in their cohort of 45 patients undergoing ICUD (36). The use of ICG, particularly antegrade via percutaneous nephrostomy tube if in place, can identify ischemic areas of the distal ureter prior to anastomosis due to lack of fluorescence (31).

The need for intraoperative or perioperative blood transfusion in patients undergoing radical cystectomy has been previously identified as an independent risk factor for overall mortality and high grade complications in the ORC and RARC literature (32,40–42). ICUD has been shown to be associated with less blood loss compared to ECUD. Interestingly, the IRCC noted a significantly decreased rate of blood transfusion in the ICUD cohort compared to ECUD (4% *vs.* 19%), though there was a small but statistically significant increase in incidence of high grade complications in the ICUD group (13 *vs.* 10%, $P=0.02$) (9). This is likely attributed to high grade complications occurring more frequently early in the learning curve, as high grade complication rate decreased with time in the ICUD cohort but not in the ECUD group. Of note, ICUD was not an independent predictive factor of high grade complications in their assessment.

Conclusions

RARC with ICUD is a minimally invasive alternative to conventional ORC. ICUD is technically demanding though the learning curve can be surmounted with consistent exposure to the procedure. Variations in technique exist, though non-continent, continent cutaneous and orthotopic continent diversions have all been reported with acceptable oncologic and functional outcomes. Overall complication rates are similar to ECUD and ORC. Potential advantages of ICUD include decreased rates of intraoperative blood transfusion and distal ureteral ischemia along with faster convalescence. An ongoing prospective, randomized clinical trial comparing RARC with ICUD to ORC will help clarify these benefits.

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Footnote

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