



Robot-Assisted Intracorporeal Neobladder and Ileal Conduit Urinary Diversion: Technique, Current Status, and Outcomes

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Abstract

Although open radical cystectomy (ORC) remains the gold standard of care for muscle-invasive bladder cancer, robot-assisted radical cystectomy (RARC) continues to gain wider acceptance. The technique of robot-assisted radical cystectomy (RARC) has evolved significantly since its inception more than 10 years ago. Several high-volume centers have reported standardized techniques with refinements and subsequent oncological and functional outcomes. We summarise published outcomes for totally intracorporeal RARC in the chapter. Totally intracorporeal RARC aims to offer the benefits of a complete minimally invasive approach while replicating the oncologic outcomes of open surgery. In this chapter, we focus on the steps of intracorporeal urinary diversion in RARC, describing our approach, which has been developed over the past 10 years. We have described the Karolinska technique for both intracorporeal ileal conduit formation and neobladder formation. Our structured approach to RARC has enabled us to develop this complex service

while maintaining patient outcomes comparable with ORC series. We conclude that the refinement of techniques for RARC and urinary diversion over the past 10 years has made it safe, reproducible, and oncologically sound.

Keywords

Neobladder · Radical cystectomy · Robotic cystectomy · Robot assisted radical cystectomy · Totally intracorporeal · Surgical technique · Intracorporeal orthotopic neobladder · Intracorporeal ileal conduit

Introduction

The creation of the urinary diversion is a challenging surgical part after radical cystectomy and holds a special place in the development of urological practice. Following cystectomy, urine can be diverted either into an incontinent stoma, into a continent urinary reservoir catheterized by the patient or controlled by the anal sphincter, or into an orthotopic bladder substitute so that the patient voids per urethra.

The history of urinary diversion is almost more than one and half centuries old. Simon was the first to describe a urinary diversion, using intestinal segments in 1852 [1]. Ureterocutaneostomy or transuretero-ureterocutaneostomy, the simplest form of urinary diversion, was the first diversion

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which has been tried initially. Strictures and scarring of the ureters were common problems, which later led to the use of intestinal segments of ileum or colon to create conduits.

In the late nineteenth and early twentieth centuries, in the absence of prophylactic antibiotic treatment, urinary diversion using bowel segments carried a high risk for peritonitis. When Coffey in 1911 [2] introduced a new method for ureteric implantation, ureterosigmoidostomy became the most frequently used technique. With increasing concern over secondary colonic malignancy, fewer ureterosigmoidostomies were performed, as it became unpopular because of the high incidence of tumor occurrence at the anastomosis between the ureters and the colon [3].

The ileal conduit, first described by Zaayer in 1911, was established as a standard technique by Bricker in 1950 [4]. At the same time, Ferris and Oedel demonstrated that hyperchloremic metabolic acidosis was common in 80% of the patients treated with ureterosigmoidostomy [5]. Thus the ileal conduit became the preferred form of urinary diversion. Longer follow-up has shown that ileal conduits do have significant physical and psychological morbidity, and this has stimulated the increasing use of continent urinary diversion and orthotopic bladder substitutes.

The first attempts to create a continent urinary diversion were undertaken by Tizzoni and Foggi in 1888 [6]. They replaced the bladder in a female dog by an isoperistaltic ileal segment. Mauclair, in 1895, used the isolated rectum as a urinary reservoir [7]. Sinaiko was the first to use the stomach for the creation of a urinary reservoir in 1956 [8]. Two findings were essential for the development of modern continent urinary diversion: Kock established the principle of bowel detubularization to create a low-pressure reservoir, and Lapidus popularized the use of clean intermittent catheterization [9]. In 1969, Kock published his first results obtained with an ileal continent fecal reservoir in patients after total proctocolectomy [10] and in 1975 he transferred the principle of this technique to urinary diversion [11]. In the 1980s as surgical outcomes of cystectomy continued to improve, emphasis was directed toward improving long-term quality of life. The pioneer-

ing work of Nils Kock and Maurice Camey [12] led to a variety of continent urinary reservoirs. The majority of these used either ileal segments, like the Hautmann and Studer neobladder [13, 14], or ileocecal segments, like 'Le Bag' MAINZ II pouch [15] and the modified rectal bladder of Ghoneim [16]. These are only a few examples of continence reservoirs which are still commonly used.

In the 1990s with development of minimally invasive techniques and advances in instrumentation design the interest in laparoscopic urinary diversion following cystectomy increased dramatically. The first simple laparoscopic cystectomy for pyocystitis was performed by Parra et al. in 1992 [17]. In 1993 de Badajoz et al. published the first study on laparoscopic radical cystectomy (LRC) for muscle-invasive bladder cancer, wherein the ileal conduit urinary diversion was performed extracorporeally [18].

In 1995 Puppo et al. [19] described five cases of a combined laparoscopic and transvaginal anterior pelvic exenteration for bladder cancer. In 2001 Turk et al. described a completely intracorporeal LRC with a continent urinary diversion (rectal sigmoid pouch) [20]. A completely intracorporeal reconstruction of the entire LRC and urinary diversion procedure was reported by Gill et al., who also performed the first purely laparoscopic ileal conduit urinary diversion and laparoscopic orthotopic Studer neobladder in 2000 and 2002, respectively [21, 22].

During the last 15 years, urologists worldwide have witnessed a tremendous uptake of minimally invasive surgery due to the development of robot-assisted surgery in many urological diseases. In parallel the interest in expanding the role of robot-assisted radical cystectomy (RARC) for the management of urinary bladder cancer has risen during the last years and continues to grow. Robotic-assisted laparoscopic techniques have emerged allowing surgeons to more readily overcome the difficult learning curve and shorten operative times in minimally invasive abdominal and pelvic operations [23, 24].

The da Vinci Surgical System® (Intuitive Surgical, Inc., Sunnyvale, CA) was first introduced in 2000 [25]. After the initial report of

robot-assisted radical cystectomy [26], several investigators have described the feasibility of RARC in the management of urinary bladder cancer [27–30].

RARC has been grown steadily during the last decade and has replaced LRC in centers where the robot is available. The neobladder can be formed intracorporeally [26, 31, 32] but operative time may be reduced early in the learning curve if this is done extracorporeally through the same incision used to deliver the cystectomy specimen. It has been shown that operation time is related to surgical experience and can be reduced using a standardized approach to RARC [24].

Raza et al. [33] reported that RARC is a minimally invasive procedure with long-term follow-up which is oncologically equivalent to open radical cystectomy. Novara et al. [34] reported in a review article that minimally invasive techniques, LRC and RARC, were associated with significantly reduced blood loss, hospital stay, marginally higher operative time and similar postoperative complication rates when compared to open radical cystectomy. Yuh et al. [35] reported in a review article that RARC oncological and functional outcomes with early and intermediate follow-up analysis were equivalent to reported outcomes from open surgery. Herein we describe step by step the method used at Karolinska University Hospital for robot-assisted urinary diversion with ileal conduit and orthotopic neobladder by intra- and extracorporeal technique.

Patient Selection

Selecting the correct patient for totally intracorporeal RARC and optimising their peri-operative care is crucial to optimising outcomes. The selection process includes preoperative investigation to ensure fitness for surgery as well as specific counselling about robotic technology. Patients with decreased pulmonary compliance who cannot tolerate prolonged Trendelenburg positioning are not candidates for the robotic-assisted technique. Furthermore, if the patient has a history of previous extensive abdominal surgery, RARC

may be contraindicated. Relative contraindications include patients aged >80 years, body mass index (BMI) >30 and those with bulky disease and such cases should be avoided early in the operative learning curve.

Options for urinary diversion (UD) are discussed with the patient. Inclusion criteria for robot-assisted formation of an orthotopic ileal neobladder are the same as for open surgery, with all suitable patients primarily considered for orthotopic neobladder. If a neobladder is contraindicated or if patients prefer, they will then receive an ileal conduit. The absolute contraindications for neobladder formation are: disease infiltration of the urethra distal to the prostate, impaired renal (serum creatinine >2 mg/dL) and hepatic function, and decreased mental capability and hand dexterity. The relative contraindications include: inflammatory bowel disease (Crohn's disease), non-competent external sphincter with associated urinary incontinence, history of recurrent urethral strictures, previous abdominal or pelvic irradiation and history of severe comorbidities, elderly patients (octogenarians), or morbid obesity (BMI > 30).

Preoperative Preparation

Standard preoperative evaluation includes computed tomography (CT) of the chest, abdomen and pelvis, routine blood tests and anaesthetic review incorporating evaluation of cardiopulmonary reserve. Patients with pT2 + tumours receive preoperative neoadjuvant platinum-based chemotherapy. In RARC with intracorporeal urinary reconstruction, bowel preparation can be avoided [36]. However, irrigation of the bowel segment may be tricky and non-digestible vegetables can be seeded into the peritoneum when the small bowel segment is opened. Thus, vegetables should not be part of the diet the day before surgery. A stoma site is marked the day prior to surgery in all patients and broad spectrum intravenous antibiotics are administered at the start of the procedure. All patients should follow an enhanced recovery after surgery protocol for their peri-operative care planning [37].

Operative Setup

Patient Position

After induction of general endotracheal anesthesia a naso-gastric tube and an 18 Ch Foley urinary catheter are inserted. The patient is placed in lithotomy position with arms adducted and padded. The legs are also abducted and slightly lowered on spreader bars. The table is placed in 25° Trendelenburg position during the cystectomy and lymph node dissection. For the urinary diversion the Trendelenburg position is decreased to 10–15°.

Equipment

The technique is challenging, requiring conventional laparoscopic infrastructure as well as an assistant with high skills in conventional laparoscopy. Standard laparoscopic surgical equipment with some extra instruments is required (Ligasure® Covidien, surgical endoscopy clip applicators, laparoscopic endo-catch bags, and laparoscopic stapler for intestinal stapling).

Surgical Steps (Table 56.1)

Trocar Configuration

Port placement is critical for successful robotic surgery (Fig. 56.1). A six-port technique is used

with the camera port placed 5 cm above the umbilicus in the midline. The camera port is placed by a small mini laparotomy as described by Hasson [38] and the other ports are placed in view of the camera. A pneumoperitoneum pressure of 18 mmHg during the port placement can be helpful in creating additional tension on the abdominal wall. Two robotic ports are placed symmetrically and level with the umbilicus on the left and right side, lateral to the rectus sheath. A third robotic instrument port is placed just above and medial to the left anterior superior iliac spine through a 15-mm port thereby enabling laparoscopic stapling by the assistant when the third robotic port is temporarily disconnected. The

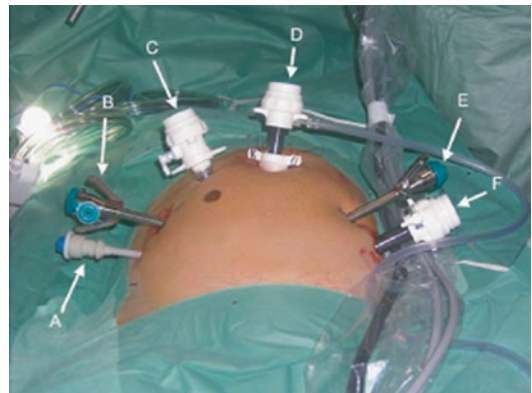


Fig. 56.1 Trocar placement for standard da Vinci system. (A) 5 mm trocar. (B) 8 mm trocar, right robot instrument. (C) 12 mm trocar, suction, bowel grasping, LigaSure. (D) camera trocar. (E) 8 mm trocar, left robot instrument. (F) 15 mm four robotic arm, specimen retrieval and stapling

Table 56.1 Surgical steps

Surgical step	Lens	Right robotic instrument	Left robotic instrument	Fourth robotic arm	Right assistant port
Anastomosis between urethra and ileum	0°	Needle driver	Cadiere	Cadiere	Bowel grasper
Isolation of 50 cm ileum	0°	Cadiere	Cadiere	Not in use	Endo-GIA 60 mm
Detubularization of ileal segment	0°	Scissors	Cadiere	Not in use	Suction device
Suturing of the posterior wall	0°	Needle driver	Cadiere	Cadiere	Grasper and hook
Folding of the neobladder and suturing the anterior wall	0°	Needle driver	Cadiere	Cadiere	Grasper and hook
Anastomosis between ureters and afferent limb	0°	Needle driver	Cadiere	Cadiere	Suction device
Placement of ureteric stents	0°	Cadiere	Cadiere	Not in use	Not in use
Closing of the neobladder	0°	Needle driver	Cadiere	Cadiere	Hook and suction device

fourth port (5 mm right assistance port) is placed approximately 5 cm above the right anterior superior iliac spine in the mid-axillary line. The fifth (15 mm) port is positioned approximately 5 cm above the left anterior superior iliac spine for the insertion of the fourth robotic arm instrument. During the intracorporeal construction of the urinary diversion the fourth arm port will be removed from the 15-mm port above the left anterior superior iliac spine allowing intestinal stapling through this port. The sixth (12 mm) assistant port is placed midway between the right robotic arm port and the camera port approximately 2 cm above the camera port. The pneumoperitoneum can then be reduced to 10–12 mmHg.

Urinary Diversion

Orthotopic Neobladder, Intracorporeal Technique

Anastomosis Between the Urethra and Ileum

After completing the radical cystectomy and the ePLND the urinary diversion is performed. For the urinary diversion the robot is undocked and the Trendelenburg position is decreased to 10–15° before re-docking, so as to facilitate the bowel dropping into the pelvis.

The first step is to perform an anastomosis between the ileum and the urethra. The 0° lens is used for this initial step. The ileum is sufficiently mobilized in order to reach down to the urethra. This is important for two reasons, first the anastomosis between the neobladder and urethra can be performed without tension, and second the neobladder will be placed correctly in the small pelvis during the whole procedure. This will help during construction of the neobladder by running suture. A 20 Ch opening (Fig. 56.2) is made in the antimesenteric site of ileum, using robotic scissor. The anastomosis is performed according to the Van Velthoven technique with a two times 16 cm 2–0 Quill® suture, allowing for 10–12 suture passes (Fig. 56.3). A needle driver and a cadriere are used to establish the anastomosis.

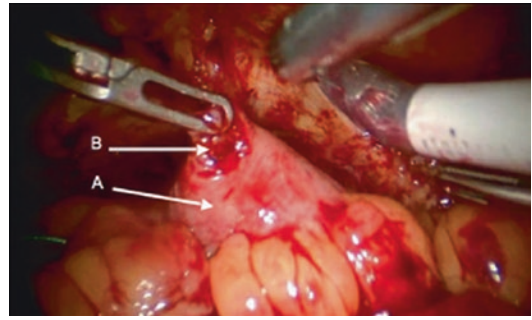


Fig. 56.2 An opening (B) in ileum (A) is performed to allow the passing of a 20 Ch catheter

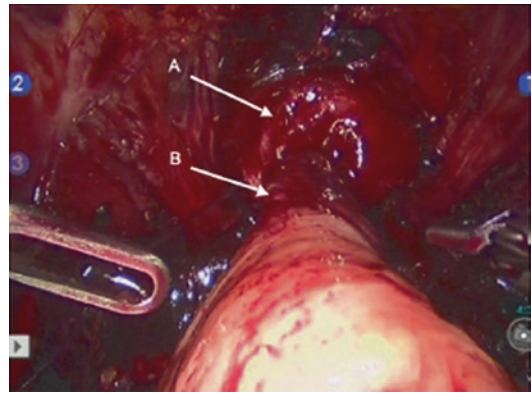


Fig. 56.3 Anastomosis between urethra (A) and ileum (B)

Isolation of 50 cm Ileum

The orthotopic neobladder is fashioned from a 50 cm segment of terminal ileum. The intestine is isolated using laparoscopic Endo-GIA with a 60 mm intestinal stapler (Fig. 56.4). The staple is inserted by the assisting surgeon, using the 15 mm port on the left side. The ileum is stapled 40 cm proximal to the urethral–ileal anastomosis. The continuity of the small bowel is restored by using Endo-GIA with a 60 mm intestinal stapler, positioning the distal and proximal end of the ileum side to side with the anti-mesentery part facing each other (Fig. 56.5). An additional transverse firing of the Endo-GIA staple is used to close the open ends of the ileal limbs (Fig. 56.6). Stay sutures may be used to attach the intestines before stapling them together.

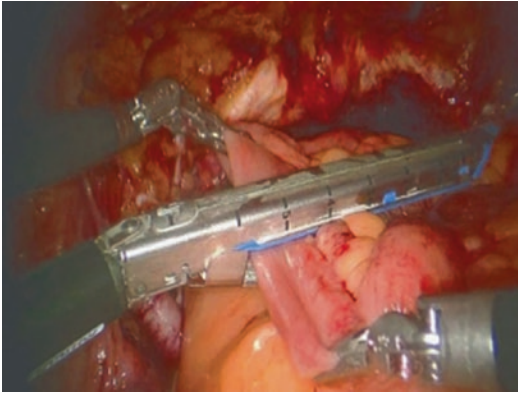


Fig. 56.4 Stapling of ileum using Endo-GIA 60 mm

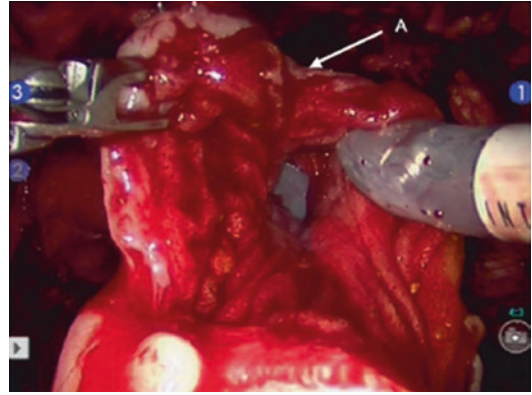


Fig. 56.7 Detubularization of ileum, antimesenterically (A) in order to create the neobladder

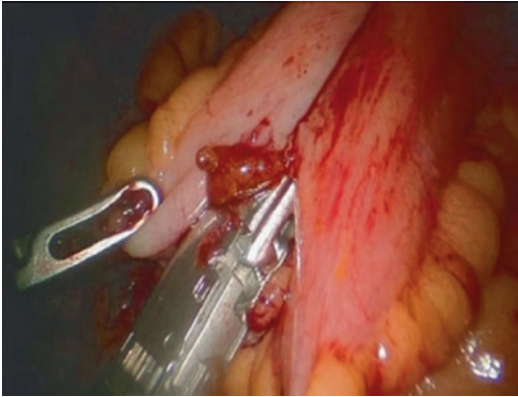


Fig. 56.5 Side-to-side anastomosis of ileum by Endo-GIA 60 mm

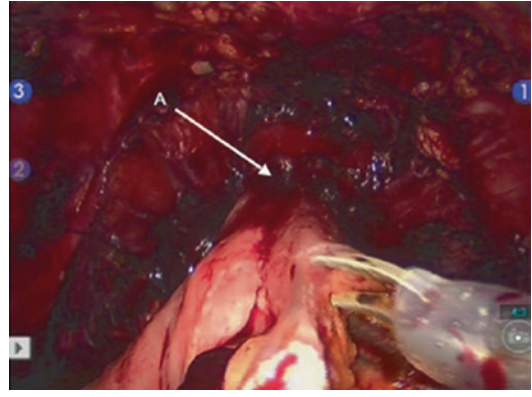


Fig. 56.8 Detubularization close to the ileourethral anastomosis (A), special care is taken not to interfere with the anastomotic suture

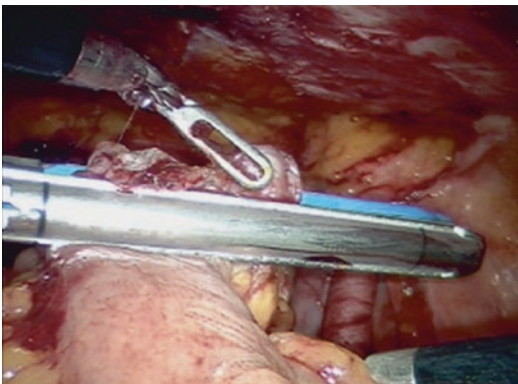


Fig. 56.6 Closing of the open end of ileal limbs using the Endo-GIA staple

Detubularization

The distal 40 cm of the isolated ileal segment is detubularized along its antimesenteric border with cold scissors (Fig. 56.7), leaving a 10 cm intact proximal isoperistaltic afferent limb. Care is taken not to interfere with the sutures used for the anastomosis to the urethra (Fig. 56.8).

Formation of Studer Neobladder

After detubularization, the posterior part of the Studer reservoir is closed using multiple running sutures (15 cm 3–0 V-Loc®) in a seromuscular fashion, avoiding suturing the mucosa. After the

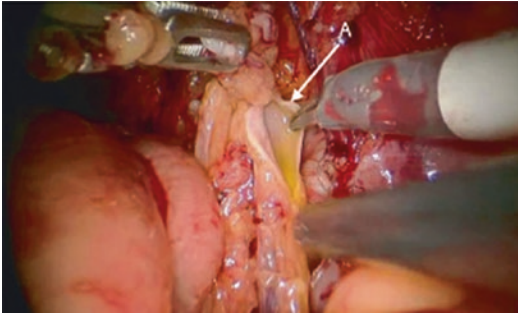


Fig. 56.9 Spatulation of the right ureter (A)

posterior part is sutured, the distal half of the anterior part of the reservoir is sutured, using the same suture. The 0° or 30° lens can be useful for this part of procedure. The proximal half of the anterior part of the reservoir is left open and is closed in the last part of the procedure.

Ureteric Entero-Anastomosis

The anastomosis between the ureters and the afferent limb is performed using the Wallace technique [39]. Using the fourth arm the ureters are aligned holding the ties attached to the Hem-o-lok clips. The ureters are then incised and spatulated for 2 cm (Fig. 56.9). The posterior walls of the ureters are sutured side-to-side, using a 15 cm running 4–0 Biosyn suture (Fig. 56.10). Before the anastomosis between the ureters and the intestinal loop is made, two single-J 40 cm ureteric stents are introduced with the Seldinger technique [40] through two separate 4-mm incisions at the lower part of abdominal wall (Fig. 56.11). Using the Cadiere forceps the stents are pulled through the afferent limb and pushed up into the ureters on each side (Fig. 56.12). The ureters are then sutured to the afferent limb of the Studer pouch, using a two-times 16 cm 3–0 Quill suture with a needle on each end (Fig. 56.13). After the entero-ureteric anastomoses are completed the stents are sutured and fixed to the skin.

Closure of the Studer Reservoir

The remaining part of the neobladder is then closed with a running 3–0 V-Loc suture. The balloon of the indwelling catheter is filled with 10 mL sterile water. The neobladder is then filled

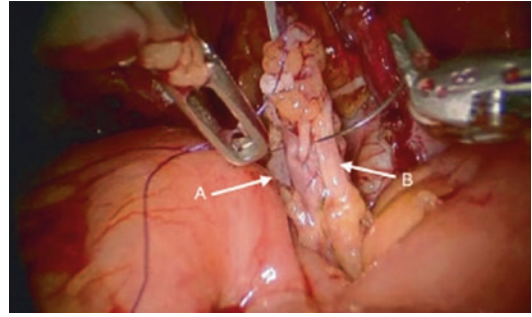


Fig. 56.10 Suture of left (A) and right (B) ureter side to side, according to the Wallace technique

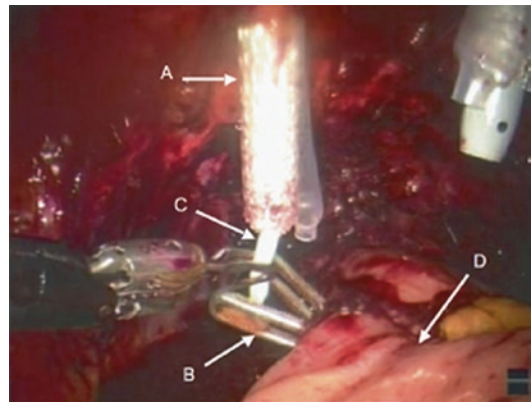


Fig. 56.11 Placement of uretric stent through a 3 mm port (A). Right robotic instrument (B) grasps the tip of the stent (C) and pulls in upward through the afferent limb of Studer reservoir (D)

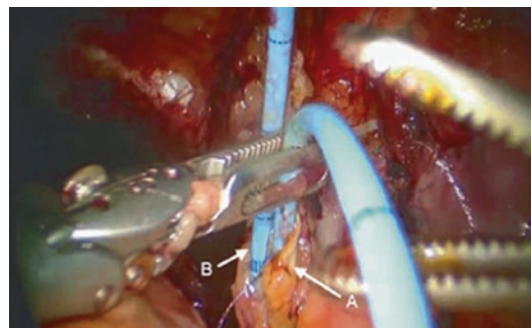


Fig. 56.12 Placement of stent up through the right ureter (A). The left uretric stent is already in place (B)

with 50 mL of saline to check for leakage (Fig. 56.14). Extra suturing to secure a watertight reservoir and anastomosis is fundamental to

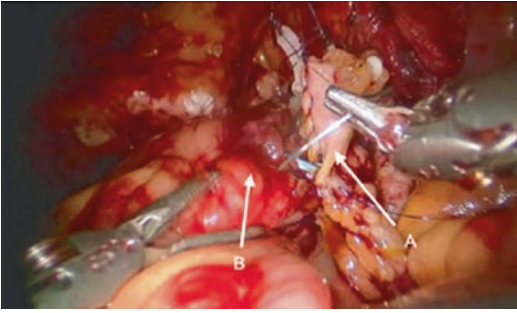


Fig. 56.13 Anastomosis between Wallace plate (A) and afferent limb (B) of the Studer reservoir, using seromucosal suturing technique

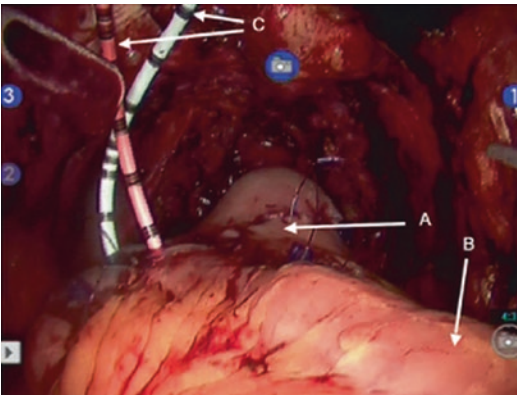


Fig. 56.14 After the neobladder (A) is completed it is filled with 50 cc saline to check for leakage. The anastomosis between ureters and afferent limb (B) is also checked for leakage. The ureteric stents (C) are placed separately in the Studer reservoir

decreasing post-operative complications. A 21F passive drain is introduced and placed in the small pelvis. Drain fluid is sent for biochemical analysis the morning after surgery and if there is no indication of urine leakage the drain is removed on day 1 post-operatively [36]. The urethral catheter is removed after 21 days. We do not place a suprapubic catheter.

Ileal Conduit, Intracorporeal Technique

Twenty centimeter intestine is isolated from the terminal ileum, using Endo-GIA with a 60 mm intestinal stapler. The continuity of the small bowel is restored as described above. The distal end of the conduit is fashioned as a stoma by surgical assistant at a previously marked site on the

abdominal wall. The left ureter is tunneled under the sigmoid mesentery to the right side. The ureters are then incised and spatulated 2 cm. The Wallace technique is used here as described above. Single-J 40 cm ureteric stents are then introduced through the isolated ileal segment (ileal conduit), using a suction tube for a protective channel avoiding intestinal perforation. The stents are then pushed up into the ureters on each side and the ureteroenteric anastomosis is completed, using a two-times 16 cm 3–0 Quill® suture which has a needle on each end.

Special Consideration

Patient Position

Care should be taken for using a pneumatic leg compression system due to risk of decreased vascular perfusion during the procedure [37]. To avoid cardiovascular complications the patient is started on anticoagulant treatment with low molecular weight heparin according to his body weight the evening before surgery until the patient is fully mobilized. It is feasible to perform the urinary diversion with 10–15° Trendelenburg, since higher degree of Trendelenburg is to be avoided in order to minimize the risk for cardiopulmonary complications.

Port Position

It is always important to make sure that the fourth arm port and the left robotic arm port are not in a same superior-inferior alignment to avoid clashing of robotic arms.

Urethral-Neobladder Anastomosis

The anastomosis between the urethra and the ileum (see Fig. 56.2) should be the first step in the formation of an intracorporeal orthotopic neobladder. This is a critical step because the anastomosis can be performed without tension, and the neobladder will be placed correctly in the small pelvis during the whole procedure.

Steps to Avoid Complication

Shoulder pads should be avoided due to the high risk of plexus damage. Care should be taken during the tunnelling of the left ureter behind the

colon sigmoid and during the extended lymph node dissection to avoid damaging any vascular structures. It is important to check for leakage after the neobladder has been created. Extra suturing to secure a watertight reservoir and anastomosis is fundamental to decrease postoperative complications.

Current Status and Outcomes

Construction of the urinary diversion after RARC is probably the most challenging part of the procedure, especially if using a totally intracorporeal approach. Since the first robot-assisted radical cystectomy (RARC) by Beecken et al. in 2003 [26] RARC has been gradually adopted as a surgical alternative to open cystectomy. As recently as 2010 the number of centres performing this surgery appeared limited, with only ~500 cases being reported in the worldwide literature [41], but by 2012 this had increased to ~1000 cases [42]. Results from more than 2000 RARC cases worldwide have now been published [34]. The first papers publishing long-term oncological outcomes show results that are comparable to published open series [33] and reviews have concluded that functional outcomes and complication rates are also comparable [34, 35]. The operative time used for the reconstruction, early in the surgeons learning curve, is one of the important factors in the decision between performing the diversion extra- or intracorporeally. Currently the vast majority of RARC in the United States are completed with an extracorporeal approach to the urinary diversion by extending the mini-incision used for removal of the specimen [26, 43–45]. In a recent multi-institutional report from the USA only 3% of patients had a totally intracorporeal approach [46]. Robot-assisted intracorporeal ileal conduit and orthotopic neobladder have been described in the literature [26, 47–49]. There is a growing body of evidence that intracorporeal urinary diversion is becoming increasingly utilised and that there are potential advantages to the patient if they undergo a totally intracorporeal approach to RARC [50].

Table 56.2 presents data from case series of intracorporeally performed urinary diversions performed at single institutions.

Currently, there is a limited amount of data on functional outcomes. Whereas in robot-assisted radical prostatectomy (RARP) surgery there is a potential trade-off between oncological and functional outcomes, in RARC functional outcomes are dependent on various factors and surgical choices, e.g., continent vs non-continent diversion, with additional variables such as natural voiding vs required intermittent self-catheterization. Although continence rates after RARC are directly related to the surgical approach, they are influenced by multiple factors including patient age and mental status, an intact and innervated urethral sphincter, urethral length, low-pressure/large-capacity reservoir (>300 mL), absence of bacteriuria, and completeness of voiding. Continence after orthotopic bladder substitution continues to improve up to 12 months after surgery. It is therefore preferable to assess continence stratified by daytime and night-time continence and by gender [51, 54]. Similar conclusions were reached in the 2012 EAU International Consultation on Bladder Cancer [55] which reviewed the data published on urinary diversion between 1970 and 2012 and found that in patients with open radical cystectomy and orthotopic bladder substitution, day- and night-time continence is achieved in 85–90% and 60–80%, respectively. If we consider totally intracorporeal continent urinary diversion, in most published series a Studer neobladder has been created [31, 48, 49, 51] and, although current cohorts are small, functional outcomes reported are encouraging. Tyrirtzis et al. [51], in a series of 70 patients, reported daytime continence of 88.2% in male patients who had undergone nerve-sparing surgery, whilst night-time continence reached 73.5% at 12 months. Similar rates were achieved for males who had undergone non-nerve-sparing surgery at 12 months (83.3% and 88.9%, respectively). Of female patients, 66.7% were found to be continent during the day and 66.7% at night at 12 months. All continence rates showed significant improvement at 12 months compared with the

Table 56.2 Robotic-assisted radical cystectomy with intracorporeal urinary diversion

Authors (ref.)	Institution	Number of patients	Type of intracorporeal urinary diversion (number)	Mean operative time (min)	Mean perioperative blood loss (mL)	Mean postoperative hospital stay (days)	Erectile function and continence
Collins et al. [30]	Karolinska Institutet	113	Ileal conduit (43) Orthotopic neobladder (70)	292 (conduit) 420 (neobladder)	200 (conduit) 500 (neobladder)	9 (conduit) 9 (neobladder)	NR
Tyritzis et al. [51]	Karolinska Institutet	70	Orthotopic neobladder (70)	420	500	9	88% continent during daytime and 72% at night. 58% of men were potent with or without PDE5I
Goh et al. [48]	Keck School of medicine, University of Southern California, Los Angeles	15	Ileal conduit (7) Orthotopic neobladder (8)	450	225	8	Neobladder patients 75% continent during the daytime. Night-time continence and erectile function NR.
Kang et al. [52]	Korea University School of Medicine	4	Ileal conduit (3) Orthotopic neobladder (1)	510 (conduit) 585 (neobladder)	400 (conduit) 500 (neobladder)	14	NR
Canda et al. [48]	Ankarav Ataturk Training and Research Hospital	27	Ileal conduit (2) Orthotopic neobladder (25)	594	430	10.5	64.7% daytime continence and 17.6% night-time continence. Erectile function NR.
Pruthi et al. [53]	University Hospital of North Carolina	12	Ileal conduit (9) Orthotopic neobladder (3)	318	221	4.5 (conduit) 5 (neobladder)	NR
Sala et al. [31]	UCI Medical Centre, University of California, Irvine	1	Orthotopic neobladder	720	100	5	Continent daytime
Balaji et al. [32]	University of Nebraska Medical Center, Omaha, Nebraska	2	Ileal conduit	600	435	6	NR
Beecken et al. [2, 6]	J.W. Goethe University, Frankfurt	1	Orthotopic neobladder	510	200	10	NR

NR not reported

6-month follow-up. A total of 81.2% of male patients were potent with or without phosphodiesterase type 5 inhibitor medication at 12 months. In that series, all eight female patients received a nerve-sparing procedure by preserving the autonomic nerves on the anterior vaginal wall. Of the evaluated male nerve-sparing, male non-nerve-sparing and female patient groups 84.4, 23.8% and 66.7% of patients, respectively, were sexually active postoperatively. Goh et al. [48] reported daytime continence in six out of eight patients at a mean (range) follow-up of 3.1 (3–21) months. Canda et al. [49] reported daytime continence in 11 out of 17 patients at a mean (range) follow-up of 6.4 (2–12) months, four had mild and two had severe daytime incontinence. In sexual functionality in females, important outcome measures after the reconstruction of the vagina include both the ability to have sexual intercourse and the absence of dyspareunia (see Table 56.2).

RARC surgery is complex surgery with several important outcome measures. It is crucial to optimize both oncological and functional outcomes whilst minimizing complications. With time and increased experience, operative times, functional and oncological outcomes will continue to improve [24]. Totally intracorporeal RARC has potential advantages with the literature showing consistent advantages, such as blood loss and length of stay, compared with open radical cystectomy [34]. However, the outcomes of prospective randomized controlled trials comparing RARC with intracorporeal and extracorporeal urinary diversion and/or standard open radical cystectomy are awaited to confirm the current findings. Measures of optimum outcome should include, negative surgical margins, cancer specific survival at 3 and 5 years, absence of major complications in the 30- and 31–90-day periods, daytime and night-time continence at 12 months, sexual activity, plus measures of length of hospital stay and time to return to normal activities. Comparative studies should also include quality-of-life or overall satisfaction scores [50].

References

1. Simon J. Ectopia vesicae; operation for directing the orifices of the ureters into the rectum; temporary success; subsequent death; autopsy. *Lancet*. 1852;2:568.
2. Coffey RC. Physiologic implantation of the severed ureter or common bile duct into the intestine. *JAMA*. 1911;56:397.
3. Wear JB, Barquin OP. Uretersigmoidostomy. Long-term results. *Urology*. 1973;1:192–200.
4. Bricker EM. Bladder substitution after pelvic evisceration. *Surg Clin North Am*. 1950;30:1511.
5. Ferris DO, Odel HM. Electrolyte pattern of the blood after bilateral uretersigmoidostomy. *JAMA*. 1950;142:634–41.
6. Tizzoni G, Foggi A. Die Wiederherstellung der Harnblase. *Zentralbl Chir*. 1888;15:921.
7. Mauclair P. De quelques essais de chirurgie expérimentale applicables au traitement de l'exstrophie de la vessie et des anus de nature complexe. *Ann Mal Org Génitourin*. 1895;13:1080–1.
8. Sinaiko E. Artificial bladder from segment of stomach and study of effect of urine on gastric secretion. *Surg Gynecol Obstet*. 1956;102(4):433–8.
9. Lapedes J, Diokno AC, Silber SM, Lowe BS. Clean, intermittent self-catheterization in the treatment of urinary tract disease. *J Urol*. 2002;167(4):1584–6.
10. Kock NG. Continent ileostomy. *Prog Surg*. 1973;12:180.
11. Kock NG, Nilson AE, Nilsson LO, Norlén LJ, Philipson BM. Urinary diversion via a continent ileal reservoir: clinical results in 12 patients. *J Urol*. 1982;128:469–75.
12. Camey M, Le Duc A. L'enterocystoplastie après cystoprostatectomie pour cancer de vessie. *Ann Urol*. 1979;13:114.
13. Hautmann RE, Miller K, Steiner U, Wenderoth U. The ileal neobladder: 6 years of experience with more than 200 patients. *J Urol*. 1993;150:40–5.
14. Studer UE, Ackermann D, Casanova GA, Zingg EJ. A newer form of bladder substitute based on historical perspectives. *Semin Urol*. 1988;6:57.
15. Fisch M, Wammack R, Muller SC, Hohenfellner R. The Mainz pouch II (sigma rectum pouch). *J Urol*. 1993;149:258–63.
16. Ghoneim MA, Ashamalla AK, Mahran MR, Kock NG. Further experience with the modified rectal bladder (the augmented and valved rectum) for urine diversion. *J Urol*. 1992;147:1252–5.
17. Parra RO, Andrus CH, Jones JP, Boullier JA. Laparoscopic cystectomy: initial report on a new treatment for the retained bladder. *J Urol*. 1992;148:1140–4.
18. Sanchez de Badajoz E, Gallego Perales JL, Reche Rosado A, de la Cruz JM G, Jimenez Garrido A. Radical cystectomy and laparoscopic ileal conduit. *Arch Esp Urol*. 1993;46:621–4.

19. Puppo P, Perachino M, Ricciotti G, Bozzo W, Gallucci M, Carmignani G. Laparoscopically assisted transvaginal radical cystectomy. *Eur Urol.* 1995;27:80–4.
20. Turk I, Deger S, Winkelmann B, Schonberger B, Loening SA. Laparoscopic radical cystectomy with continent urinary diversion (rectal sigmoid pouch) performed completely intracorporeally: the initial 5 cases. *J Urol.* 2001;165:1863–6.
21. Gill IS, Fergany A, Klein EA, Kaouk JH, Sung GT, Meraney AM, et al. Laparoscopic radical cystoprostatectomy with ileal conduit performed completely intracorporeally: the initial 2 cases. *Urology.* 2000;56:26–30.
22. Gill IS, Kaouk JH, Meraney AM, Desai MM, Ulchaker JC, Klein EA, et al. Laparoscopic radical cystectomy and continent orthotopic ileal neobladder performed completely intracorporeally: the initial experience. *J Urol.* 2002;168:13–8.
23. Schumacher MC, Jonsson MN, Wiklund NP. Robotic cystectomy. *Scand J Surg.* 2009;98:1–17.
24. Collins JW, Tyrirtzis S, Nyberg T, Schumacher MC, Laurin O, Adding C, et al. Robot-assisted radical cystectomy (RARC) with intracorporeal neobladder – what is the effect of the learning curve on outcomes? *BJU Int.* 2014;113(1):100–7.
25. Binder J, Kramer W. Robotically-assisted laparoscopic radical prostatectomy. *BJU Int.* 2001;87:408–10.
26. Beecken WD, Wolfram M, Engl T, Bentas W, Probst M, Blaheta R, et al. Robotic-assisted laparoscopic radical cystectomy and intra-abdominal formation of an orthotopic ileal neobladder. *Eur Urol.* 2003;44(3):337–9.
27. Menon M, Hemal AK, Tewari A, Shrivastava A, Shoma AM, El-Tabey NA, et al. Nerve-sparing robot-assisted radical cystoprostatectomy and urinary diversion. *BJU Int.* 2003;92:232–6.
28. Hemal AK, Abol-Enein H, Tewari A, Shrivastava A, Shoma AM, Ghoneim MA, et al. Robotic radical cystectomy and urinary diversion in the management of bladder cancer. *Urol Clin North Am.* 2004;31(4):719–29.
29. Shah NL, Hemal AK, Menon M. Robot-assisted radical cystectomy and urinary diversion. *Curr Urol Rep.* 2005;6(2):122–5.
30. Collins JW, Tyrirtzis S, Nyberg T, Schumacher M, Laurin O, Khazaeli D, et al. Robot-assisted radical cystectomy: description of an evolved approach to radical cystectomy. *Eur Urol.* 2013;64(4):654–63.
31. Sala LG, Matsunaga GS, Corica FA, Ornstein DK. Robot-assisted laparoscopic radical cystoprostatectomy and totally intracorporeal ileal neobladder. *J Endourol.* 2006;20:233–6.
32. Balaji KC, Yohannes P, McBride CL, Oleynikov D, Hemstreet GPIII. Feasibility of robot-assisted totally intracorporeal laparoscopic ileal conduit urinary diversion: initial results of a single institutional pilot study. *Urology.* 2004;63:51–5.
33. Raza SJ, Wilson T, Peabody JO, Wiklund P, Scherr DS, Al-Daghmin A, et al. Long-term oncologic outcomes following robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. *Eur Urol.* 2015;68(4):721–8.
34. Novara G, Catto JW, Wilson T, Annerstedt M, Chan K, Murphy DG, et al. Systematic review and cumulative analysis of perioperative outcomes and complications after robot-assisted radical cystectomy. *Eur Urol.* 2015;pii:S0302-2838(14)01262-7. Review
35. Yuh B, Wilson T, Bochner B, Chan K, Palou J, Stenzl A, et al. Systematic review and cumulative analysis of oncologic and functional outcomes after robot-assisted radical cystectomy. *Eur Urol.* 2015;67(3):402–22.
36. Collins JW, Adding C, Hosseini A, Nyberg T, Pini G, Dey L, et al. Introducing an enhanced recovery programme to an established totally intracorporeal robot-assisted radical cystectomy service. *Scand J Urol.* 2016;50:39–46.
37. Collins JW, Patel H, Adding C, Annerstedt M, Dasgupta P, Khan SM, et al. Enhanced recovery after robot-assisted radical cystectomy: EAU Robotic Urology Section Scientific Working Group consensus view. *Eur Urol.* 2016;pii:S0302-2838(16)30184-1.
38. Hasson HM. Open laparoscopy vs. closed laparoscopy: a comparison of complication rates. *Adv Plan Parent.* 1978;13:41–50.
39. Wallace DM. Ureteric diversion using a conduit: a simplified technique. *Br J Urol.* 1966;38:522.
40. Bigongiari LR. The Seldinger approach to percutaneous nephrostomy and ureteral stent placement. *Urol Radiol.* 1981;2(3):141–5.
41. Davis JW, Castle EP, Pruthi RS, Ornstein DK, Guru KA. Robot-assisted radical cystectomy: an expert panel review of the current status and future direction. *Urol Oncol.* 2010;28:480–6.
42. Tyrirtzis SI, Hosseini A, Jonsson M, Adding C, Nilsson A, Wiklund NP. Robot-assisted intracorporeal formation of the ileal neobladder. *J Endourol.* 2012;26:1570–5.
43. Guru KA, Nyquist J, Perlmutter A, Peabody JO. A robotic future for bladder cancer? *Lancet Oncol.* February, 2008;9(2):184.
44. Menon M, Hemal AK, Tewari A, Shrivastava A, Shoma AM, Abol-Ein H, et al. Robot-assisted radical cystectomy and urinary diversion in female patients: technique with preservation of the uterus and vagina. *J Am Coll Surg.* 2004;198:386–93.
45. Hemal AK. Role of robot-assisted surgery for bladder cancer. *Curr Opin Urol.* 2009;19(1):69–75.
46. Smith AB, Raynor M, Amling CL, Busby JE, Castle E, Davis R, et al. Multi-institutional analysis of robotic radical cystectomy for bladder cancer: periop-

- erative outcomes and complications in 227 patients. *J Laparoendosc Adv Surg Tech A*. 2012;22:17–21.
47. Collins JW, Sooriakumaran P, Sanchez-Salas R, Ahonen R, Nyberg T, Wiklund NP, et al. Robot-assisted radical cystectomy with intracorporeal neobladder diversion: the Karolinska experience. *Indian J Urol*. 2014;30(3):307–13.
 48. Goh AC, Gill IS, Lee DJ, de Castro Abreu AL, Fairey AS, Leslie S, et al. Robotic intracorporeal orthotopic ileal neobladder: replicating open surgical principles. *Eur Urol*. 2012;62:891–901.
 49. Canda AE, Atmaca AF, Altinova S, Akbulut Z, Balbay MD. Robot-assisted nerve-sparing radical cystectomy with bilateral extended pelvic lymph node dissection (PLND) and intracorporeal urinary diversion for bladder cancer: initial experience in 27 cases. *BJU Int*. 2012;110:434–44.
 50. Collins JW, Wiklund NP. Totally intracorporeal robot-assisted radical cystectomy: optimizing total outcomes. *BJU Int*. 2014;114(3):326–33.
 51. Tyritzis S, Hosseini A, Collins JW, Nyberg T, Jonsson MN, Laurin O, et al. Oncologic, functional, and complications outcomes of robot-assisted radical cystectomy with totally intracorporeal neobladder diversion. *Eur Urol*. 2013;64:734–41.
 52. Kang SG, Ko YH, Jang HA, Kim J, Kim SH, Cheon J, Kang SH. Initial experience of robot-assisted radical cystectomy with total intracorporeal urinary diversion: comparison with extracorporeal method. *J Laparoendosc Adv Surg Tech A*. 2012;22(5):456–62.
 53. Pruthi RS, Nix J, McRackan D, Hickerson A, Nielsen ME, Raynor M, Wallen EM. Robotic-assisted laparoscopic intracorporeal urinary diversion. *Eur Urol*. 2010;57(6):1013–21.
 54. Kassouf W, Hautmann RE, Bochner BH, Lerner SP, Colombo R, Zlotta A, et al. A critical analysis of orthotopic bladder substitutes in adult patients with bladder cancer: is there a perfect solution? *Eur Urol*. 2010;58:374–83.
 55. Hautmann RE, Abol-Enein H, Davidsson T, Gudjonsson S, Hautmann SH, Holm HV, et al. ICUD-EAU International Consultation on Bladder Cancer 2012: urinary diversion. *Eur Urol*. 2013;63:67–80. <https://doi.org/10.1016/j.eururo.2012.08.050>.