Chapter

Intracorporeal Urinary Diversion of Robot-Assisted Radical Cystectomy

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Abstract

With the widespread utilization of robot-assisted radical cystectomy (RARC) that demonstrated non-inferiority compared to open radical cystectomy in terms of several outcomes, urinary diversions are now performed for both extracorporeal and intracorporeal procedures. The potential benefits of intracorporeal urinary diversion (ICUD) include smaller incisions, reduced pain, reduced intraoperative blood loss, reduced bowel handling and exposure, and third space loss. ICUD following radical cystectomy requires many steps and a careful stepwise progression. Surgical volumes (RARCs per year) per center and per surgeon appear to be correlated with a reduction in complications. The European Association of Urology guidelines recommend that hospitals should perform at least 10, and preferably more than 20 operations annually. With the aim of generalizing ICUD, this chapter will discuss the following items: (1) Technique of intracorporeal ileal conduit; (2) Perioperative comparison of intracorporeal and extracorporeal urinary diversion in RARC; (3) Hybrid technique in robot-assisted intracorporeal ileal conduit; and (4) Intracorporeal ileal neobladder.

Keywords: intracorporeal urinary diversion, robot-assisted radical cystectomy, ileal conduit, ileal neobladder, surgical technique, perioperative outcomes

1. Introduction

Over the last decade, robot-assisted radical cystectomy (RARC) has been gradually adopted and has been shown to maintain oncological equivalence compared to open radical cystectomy (ORC) [1–4], including in randomized control trials (RCTs) [5–10]. In addition, RCT evaluating quality of life have reported stability in RARC compared to ORC [11]. The development of minimally invasive surgical techniques has been widely used in a variety of surgical with the adaptation of minimally invasive techniques is to minimize surgical morbidity and improve recovery. With regard to urinary diversion following radical cystectomy, intracorporeal urinary diversion (ICUD) has become more common in recent years in place of extracorporeal urinary diversion (ECUD). According to data of the International Robotic Cystectomy Consortium (IRCC) database, comprising data from 26 institutions, ICUD increased at a rate of 9–11% per year, from 9% of all urinary diversions in 2005 to 97% in 2015 [12]. This trend was also observed for intracorporeal ileal neobladder alone [13]. This chapter mainly explains ICUD techniques and perioperative outcomes.

2. Technique of intracorporeal ileal conduit

This chapter describes the method when using the da Vinci Surgical System (Intuitive Surgical Inc., Sunnyvale, CA, USA).

2.1 Port placement

Port placement is similar to robot-assisted radical prostatectomy (RARP), and both assistant ports are often 12 mm ports. All ports are placed approximately 2 cm higher than the usual position for RARP.

2.2 Preliminary steps of ICUD

After the completion of radical cystectomy, specimens are placed in an impermeable retrieval bag. In female patients, the specimen may be extracted through the vagina. In male patients, the specimens can be removed either through the subsequent ostomy sites or by enlarging the 12-mm camera port. Before undocking, the left ureter is guided to the right side through the back of the sigmoid colon and fixed to the ventral peritoneum through support threads over both ureters.

2.3 Repositioning

The robot is undocked and the Trendelenburg position is returned to 0–15 degrees. The robot is then re-docked in this new bed position. This maneuver allows the small bowel to return to the lower abdomen and pelvis, facilitating subsequent bowel manipulation for the intracorporeal diversion.

2.4 Determination of the ileal segment for diversion

The first step is to identify the ileocecal junction. Preserve at least 20 cm of ileum proximal to the ileocecal valve by introducing a 20-cm silk suture into the abdomen and using it to measure the length and distance of the bowel tract (**Figure 1A**). A segment of ileum is then identified and selected for the urinary diversion, tagging the proximal and distal ends of the bowel (**Figure 1B**). A 15–20 cm length of ileum is then resected depending on the patient's body habitus. Cadiere forceps, which are less traumatic than the Prograsp or Maryland forceps, are recommended for bowel manipulation.

2.5 Ileal resection and reconstruction

After creating two mesenteric windows, the bowel lumen is divided proximally and distally by introducing a 45 or 60 mm stapler into the lateral assistant port using the da Vinci Xi Endo Wrist Stapler with SmartClamp technology. Indocyanine green (ICG) and the Firefly system may be used when undergoing ileal resection [14]. Proximal and distal bowel ends are identified and positioned in a side-to-side fashion. After the closed end of the bowel has been cut off with scissors and released, the da Vinci Xi Endo Wrist Stapler is inserted in the bowel segment, and side to side bowel anastomosis is carried out using one 45 or 60 mm bowel loads (**Figure 1C**). A final 45 or 60 mm bowel load closes the horizontal part. The mesenteric window is closed with a shallow running suture to prevent internal bowel herniation.

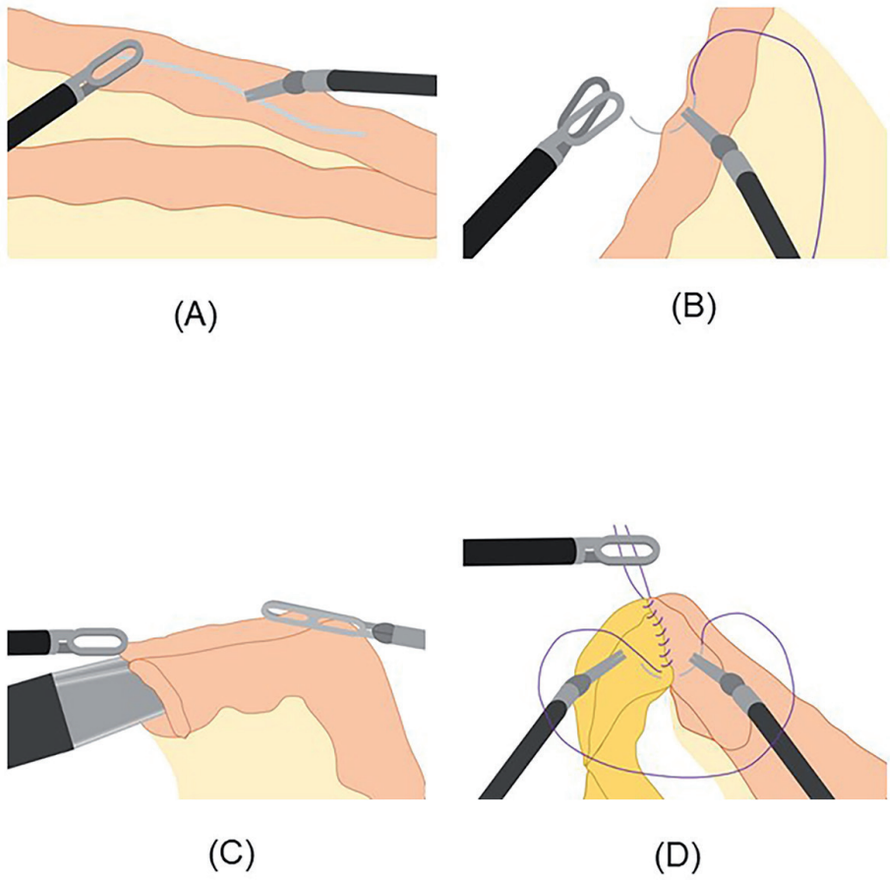

Figure 1.
(A) Measuring distance of terminal ileum; (B) tagging the ileum to mark the incision site; (C) the stapler is closed and fired to create the anastomosis; (D) creation of Wallace posterior plate.

2.6 Ileal conduit diversion

Here we describe the Wallace surgical technique for uretero-ileal anastomosis [15]. The first step is to create the uretero-uretero anastomosis. The distal end of both ureters are spatulated using Monopolar Scissors to at least 20 mm to match the caliber of the ileum. The distal end of both spatulated ureters are marked as stay sutures using a 4/0 absorbable suture. The inner opposite borders of both ureters are over-sewn using a running fashion with a 4/0 absorbable suture. The uretero-ileal anastomosis is constructed with two 15 cm lengths of 4/0 absorbable suture in a running fashion from the heel of the spatulation to the toe on each side (**Figure 1D**). After ureteroileal anastomosis is completed, a 6-Fr single-J ureteral stents are inserted into each ureter. A robotic arm is passed through the ileal conduit to guide the stent outside the ureter to the distal side of the ileal conduit. Then the anterior side of urtero-ileal anastomosis is completed. The right robotic arm is undocked and the assistant makes the stoma in the standard fashion.

3. Perioperative comparison of intracorporeal and extracorporeal urinary diversion in RARC

To date, although several observational studies have suggested advantages of ICUD over EUCD, there are no RCTs comparing the differences between these two operative methods.

The systematic review and meta-analysis [16] evaluating the perioperative outcomes between ICUD and ECUD reported no significant differences in overall and major complications between ICUD and ECUD. A subgroup analysis of high-volume centers showed that ICUD was significantly associated with a reduced risk of major complications [OR 0.57, 95% confidence interval (CI) 0.37–0.86, $p = 0.008$]. In terms of perioperative outcomes, estimated blood loss (EBL) and blood transfusion rates were significantly lower in patients who underwent an ICUD compared to those who underwent ECUD. In contrast, operative time, length of stay (LOS), and ileus and gastrointestinal (GI) related complications were not significantly different between these two methods. A subgroup analysis of low-volume centers showed that EBL and blood transfusion rates were significantly lower in patients who underwent ICUD (mean difference −121.6 ml, 95% CI −160.9 to −82.3, $p < 0.00001$ and OR 0.36, 95% CI 0.20–0.62, $p = 0.00003$, respectively).

Another systematic review and meta-analysis [17] reported that ICUD and ECUD had comparable early (<30 days) and late (30–90 days) complication rates. In terms of perioperative outcomes, EBL tended to be lower in patients who underwent an ICUD compared to those who underwent ECUD (mean difference –86 ml, 95% CI −124 to –48, $p = 0.058$). The transfusion rate was significantly lower in the ICUD group, 4.6% versus 13.9% in the ECUD group ($p < 0.001$). The weighed mean difference of operative time in the ICUD and ECUD group was 16 (95% CI −34 to 66).

There is a caveat to these studies' results. A relatively large number of urologists choose ECUD in the early stages of RARC implementation and then introduce ICUDs when they are proficient. Thus the results should be compared between the final period of ECUD and the period of ICUD implementation. With respect to proficiency after the introduction of ICUD, approximately 30 cases are expected to be needed to stabilize perioperative outcomes. In the Learning Curve estimate for RARC, almost 30 cases have been agreed upon for this particular procedure to achieve a lymph node yield of 20 and a positive resection margin rate of 5% or less [18]. A study that evaluated learning curves for three groups of approximately 30 cases each of 100 patients initially introduced to RARC revealed that the transfusion rate was low and stable after approximately 30 cases [19]. On the other hand, a retrospective analysis at a high-volume hospital reported that more than 137 cases were needed to stabilize perioperative outcomes, including major complications in 90 days, highlighting the need for substantial experience [20].

According to the systematic review and meta-analysis by Tanneru et al. [17], ICUD ileal conduits are more likely to be performed, especially in hospitals with more than 100 cases [12, 21, 22]. This is presumably because neobladder formation may be technically difficult and patient selection is more rigorous than with ileal conduits.

It has been noted that the ECUD group tends to have higher transfusion rates than the ICUD group. Several studies have shown that blood transfusions are associated with an increased risk of cancer recurrence and mortality after radical cystectomy, indicating the importance of reduced transfusion rates for oncologic outcomes [23, 24]. For intracorporeal ileal neobladder alone, analysis of a retrospective review of IRCC database reported that patients who underwent intracorporeal ileal neobladder had shorter hospital stays and fewer 30 day reoperations but were readmitted more frequently compared to those who underwent extracorporeal ileal neobladder [13].

While there is reportedly no difference in overall complication rates, ECUD is associated with a higher incidence of GI complications. It has been suggested that the reason for this is related to the fact that open surgery exposes the peritoneum to air, which is associated with an inflammatory response and can lead to postoperative

ileus [25, 26]. According to IRCC analysis, GI complications were significantly higher in patients who received ECUD (23%) compared to the patients who received ICUD (10%) [1]. With regard to the incidence of Grade 3 or higher GI, complications were reported to be significantly higher in ECUD group than ICUD group [27]. However, a study comparing 972 patients found no difference between these two methods [12]. From another viewpoint, since early mobilization and low Geriatric-8, etc. have been identified as causes of postoperative ileus development, such attention may be warranted [28].

Another typical complication of urinary diversion is ureteroenteric strictures. When anastomotic stricture occurs, surgical intervention, including invasive anastomotic reshaping, is often required. The up to 13% incidence of ureteroenteric stricture has been reported, depending on the definition, and includes both ICUD and ECUD [29]. According to the study, which evaluated the stricture rate in intracorporeal diversions with and without the use of ICG for perfusion evaluation of the distal ureter [30], stricture formation was 0% in the ICG group compared to 10.6% per patient in the non-ICG group at 12 months follow up. In an evaluation using ICG with SPY fluorescence at ECUD, the stricture rate was 0% in the ICG group versus 7.5% in the non-ICG group. The median length excised for ureters with poor distal perfusion was 3.8 cm, compared with 2.2 cm for ureters with good distal perfusion [31]. A retrospective study evaluating both methods in 127 patients reported a 3.2% incidence of stricture for ICUD and 7.4% for ECUD, with no difference between these 2 groups [22].

4. Hybrid technique in robot-assisted intracorporeal ileal conduit

The advantages of ICUD are smaller incisions, less pain, and less bowel exposure compared to ECUD [32–34]. ICUD tends to have a longer operative time in the early stages of implementation due to the complexity of the technique and steep learning curve [18, 19, 35]. The implementation of new surgical techniques requires careful stepwise progression in order to protect patients as much as possible against potential harms associated with such implementation. Herein, we describe a hybrid ICUD procedure that partially incorporates ECUD techniques.

4.1 Preliminary steps

After the completion of radical cystectomy and pelvic lymphadenectomy, the left ureter is moved to the right side of the abdomen through a window created in the mesentery behind the sigmoid colon. The robot is undocked and the Trendelenburg position is returned to 0–15 degrees.

4.2 Extracorporeal part

An extended incision (approximately 4–6 cm) is made through the camera port and the specimen is removed from the body. The incision is then covered with Smart Retractor® (TOP Inc., Tokyo, Japan). Isolate an ileal segment (approximately 15–20 cm) at least 20 cm from the ileocecal valve (**Figure 2A**). The lumen of the isolated ileum (conduit) is cleaned with saline. A skin incision is made at the site of stoma creation, creating a stoma hole. The distal end of the conduit is then pulled out of the abdominal wall through the stoma hole. Approximately 20 cm length of

silk thread is ligated at the distal end of the conduit and used as a support thread (**Figure 2B**). The collected ileum is then returned to the abdominal cavity, and the wound at the stoma site is temporarily closed with silk suture. The Smart Retractor® is covered with Free Access® (TOP Inc, Tokyo, Japan), and the abdominal cavity is re-insufflated (**Figure 2C**).

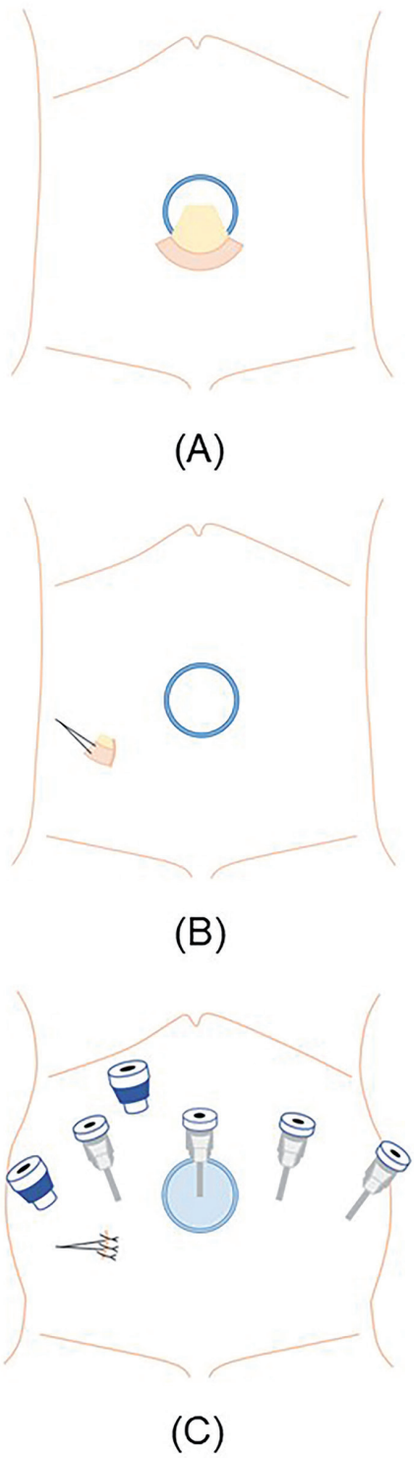

Figure 2.
(A) Extended wound and ileum harvested (approximately 20 cm); (B) Ileum temporarily pulled out through the abdominal wall and ligated with silk threads; (C) return the conduit to the abdominal cavity and re-insufflate.

4.3 Intracorporeal part

The robot is then re-docked to perform uretero-ileal anastomosis intracorporeally. Uretero-ileal anastomosis is performed by the Wallace method described above.

This method is useful until the surgeon becomes accustomed to intracorporeal manipulation.

5. Intracorporeal ileal neobladder

Bowel handling in ICUD is often a limiting step in surgical learning. Intracorporeal ileal neobladder in particular requires attention because of its large number of intraoperative manipulations. A tertiary reference center reported that 60 cases are required to stabilize the perioperative outcomes [36].

Several intracorporeal neobladder techniques were recently reported, including Studer "U" [37–42], Hautmann "W" [43], "Y" pouch [44, 45], Pyramid pouch [46], Padua style [47], Vesicia ileale Padovana [48], FloRIN style [49] with promising perioperative outcomes.

We describe a J-shaped orthotopic neobladder based on the Studer method. This procedure is relatively simple to perform.

5.1 Determination of the ileal segment for diversion

A 50 cm portion is selected, leaving at least 20 cm of ileum proximal to the ileocecal valve, and including the portion of the ileum closest to the pelvic floor. Ileal resection and reconstruction are performed as described above.

5.2 Detubularization and reshaping the ileum into a spherical neobladder

Approximately 40 cm of antimesenteric border of distal ileum is opened whereas the proximal 10 cm is maintained for afferent limb (**Figure 3A**). A 40 cm portion of the ileum is folded in two, and the posterior plate is then reconstructed using a 3/0 absorbable suture in a running fashion (**Figure 3B**). Single–J stents are placed over guide wire and the ends are advanced through the wall of the afferent limb (**Figure 3C**). The neobladder is then symmetrically folded into a spherical reservoir applying the same suture (**Figure 3D**). An opening is then made at the most dependent portion and a urethra-ileal anastomosis is performed by using a 3/0 "barbed" running suture, starting at 5 o'clock on the urethra and then proceeding clockwise. A 20 French Foley catheter is introduced into the neobladder.

5.3 Uretero-enteral anastomosis and stent placement

The anastomosis between the ureters and the afferent limb is performed using the Wallace technique. Both ureters are then anastomosed to the afferent limb using a 4/0 absorbable suture in a running fashion. The caudal side of stents are advanced to the abdominal wall through the 5 mm trocar, and then stents are pushed up through ureters to renal pelvis. The remaining part of Wallace plate is closed (**Figure 3E**) and its water–tightness is tested accordingly.

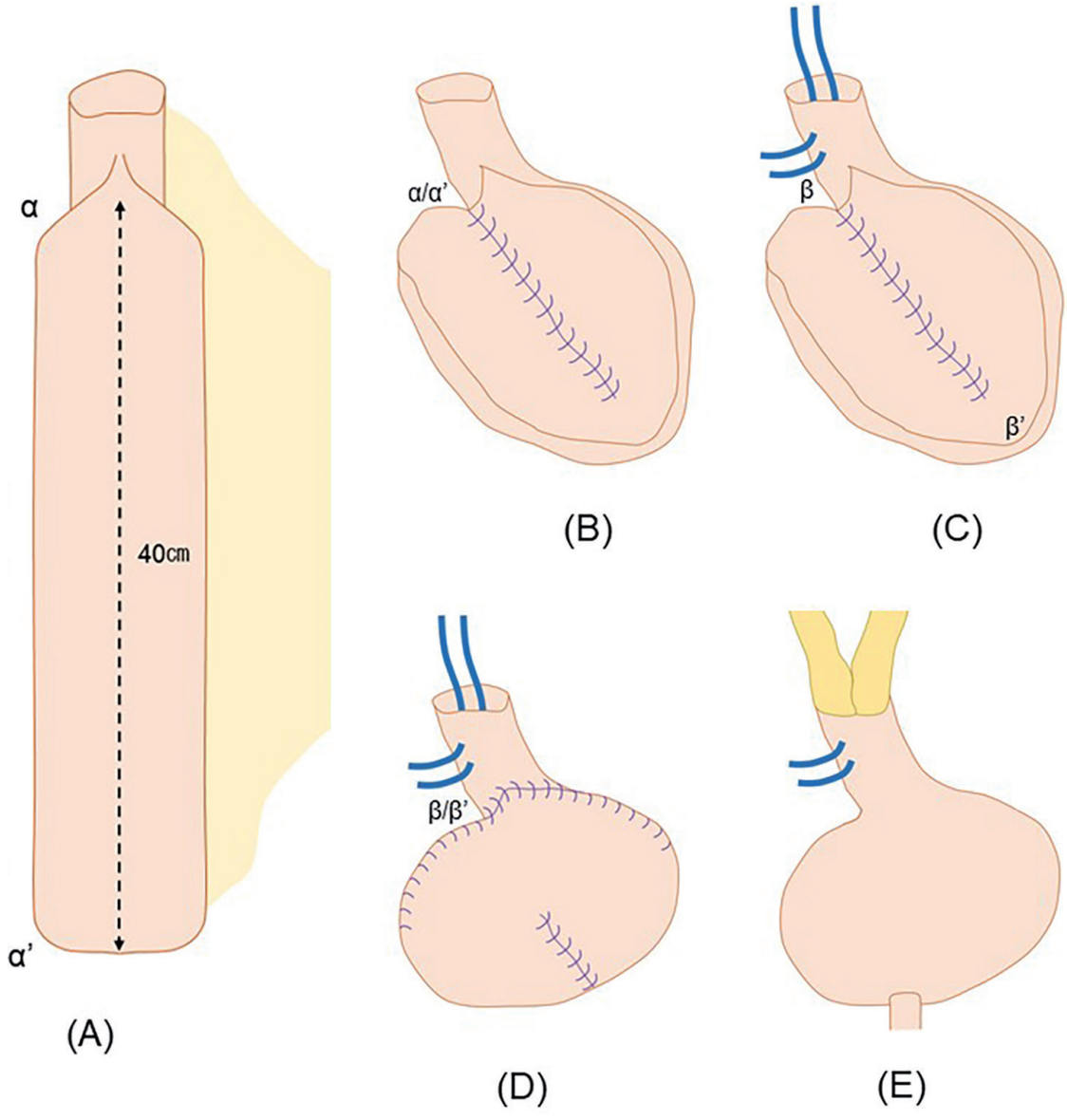

Figure 3.
(A) Detublarized ileum; (B) posterior plate of ileal neobladder (α overlaps with α′); (C) situation with ureteral stents through the afferent limb; (D) spherical reshaped reservoir (β overlaps with β′); (E) situation after completion of urinary tract anastomosis.

5.4 Postoperative management

Manual irrigation of the neobladder is performed intermittently every 8 hours. It should be noted that mucus volume will be increased after resumption of eating. The drain is removed when the amount of fluid is <200 ml. The ureteral stents are removed on the seventh postoperative day under urethrocystography. The urethral catheter is removed 3–4 weeks after operation.

5.5 Functional outcome

Functional outcomes are related to many factors such as age, mental or cognitive status, reservoir volume, and urethral length. The day time urinary continence recovery rates with less than one pad per day performed by intracorporeal Studer's method were reported to be 62–88% at 1 year [50, 51]. A study including only a small

number of 12 men reported a 100% day time urinary abstinence recovery rate defined as <1 pad per day at 1 year [52]. Retrospective study compared continence rates of RARC with intracorporeal and extracorporeal orthotopic neobladders revealed that no statistically significant difference was found in continence recovery rates [53]. In terms of potency, the recovery rate was 81.2% in nerve-sparing patients with or without PDE5 medication at 1 year (with PDE5: 50% or without medication: 31.2%, respectively) [50].

6. Conclusions

Complications of RARC with ICUD in the short-term and midterm periods were equivalent to those of ECUD. In high volume centers, ICUD tends to have fewer major complications. Furthermore, ICUD tends to have a lower incidence of GI complications than ECUD, suggesting that ICUD may be a preferred method for urinary diversion.

Conflict of interest

The authors declare no conflict of interest.

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