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## REVIEW

# Robotic intracorporeal urinary diversion: practical review of current surgical techniques

Fabrizio DAL MORO <sup>1</sup>\*, Georges P. HABER <sup>2</sup>, Peter WIKLUND <sup>3</sup>,  
Abdullah E. CANDA <sup>4</sup>, Mevlana D. BALBAY <sup>5</sup>, Arnulf STENZL <sup>6</sup>, Filiberto ZATTONI <sup>1</sup>,  
Joan PALOU <sup>7</sup>, Inderbir GILL <sup>8</sup>, James W. F. CATTO <sup>9</sup>

<sup>1</sup>University of Padua, Padua, Italy; <sup>2</sup>Glickman Urological Institute, Cleveland Clinic, Cleveland, OH, USA; <sup>3</sup>Karolinska University Hospital, Stockholm, Sweden; <sup>4</sup>Department of Urology, Yildirim Beyazit University, School of Medicine, Ankara Atatürk Training and Research Hospital, Ankara, Turkey; <sup>5</sup>Department of Urology, Memorial Şişli Hospital, Istanbul, Turkey; <sup>6</sup>Department of Urology, Eberhard-Karls University Tuebingen, Germany; <sup>7</sup>Fundació Puigvert, Barcelona, Spain; <sup>8</sup>Institute of Urology, Keck School of Medicine, USC, Los Angeles, CA, USA; <sup>9</sup>University of Sheffield, Sheffield, UK

\*Corresponding author: Fabrizio Dal Moro, University of Padua, Department of Surgery, Oncology and Gastroenterology – Urology, Via Giustiniani 2, 35128, Padova, Italy. E-mail: [fabrizio.dalmorou@unipd.it](mailto:fabrizio.dalmorou@unipd.it)

## ABSTRACT

In this practical review, we discuss current surgical techniques reported in the literature to perform intracorporeal urinary diversion (ICUD) after robotic radical cystectomy (RARC), emphasizing criticisms of single approaches and making comparisons with extracorporeal urinary diversion (ECUD). Although almost 97% of all RARCs use an ECUD, ICUD is gaining in popularity, in view of its potential benefits (*i.e.*, decreased bowel exposure, etc.), although there are a few studies comparing ICUD and ECUD. Analyzing single experiences and the data from recent meta-analyses, we emphasize the current critiques to ICUD, stressing particular technical details which could reduce operative time, lowering the post-operative complications rate, and improving functional outcomes. Only analysis of long-term follow-up data from large-scale homogeneous series can ascertain whether robotic intracorporeal urinary diversion is superior to other approaches.

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**Key words:** Cystectomy - Urinary diversion - Urinary bladder.

The “gold standard” treatment for muscle-invasive bladder cancer is radical cystectomy (RC). This procedure can be a technical challenge for urologists, even in expert hands,<sup>1</sup> and has a high morbidity rate. To reduce this morbidity surgeons have reduced surgical trauma using minimal invasive techniques. Robot-assisted radical cystectomy (RARC) with extracorporeal urinary diversion (ECUD) appears comparable to open radical cystectomy (ORC)<sup>2</sup> allowing precise and rapid removal of both bladder and lymph nodes, with lower

blood loss and fewer gastrointestinal complications than open surgery. However, extracorporeal reconstruction with ECUD potentially negates the benefits of minimal access surgery.<sup>3</sup> Surgeons have moved toward fully intra-corporeal surgery. Intracorporeal urinary diversion (ICUD) was performed for the first time by Beecken in 2003<sup>4</sup> and, although it has gradually been adopted as part of the complete RARC procedure, it does remain subject to controversy.<sup>5</sup> In this practical review, we discuss current surgical techniques to perform

ICUD reported in the literature, emphasizing criticisms of single approaches in comparison with ECUD and analysing both postoperative complications and functional outcomes.

### Extracorporeal vs. intracorporeal urinary diversion

In the USA 97% of RARCs are completed with ECUD,<sup>6, 7</sup> although the trend toward ICUD appears to be increasing.<sup>8, 9</sup> The reason for the frequent use of ECUD is that intracorporeal reconstruction is challenging technically and can be slower than open reconstruction.<sup>10</sup> Furthermore, as surgeons have to make an incision to remove the bladder and organs, some believe that the same incision can also be used for urinary diversion. In contrast, the incision for ECUD (after RARC) subjects patients to similar complications as total open surgery. Data from the International Robotic Cystectomy Consortium<sup>11</sup> suggest that ECUD and ICUD have similar oncological outcomes and overall complication rates (such as reoperation rates at 30 days), whereas ICUD appears to have fewer readmissions and lower risk of postoperative complications at 90 days.

### Benefits of intracorporeal surgery

The main potential benefits of ICUD are that this route: 1) minimizes evaporative fluid losses from the peritoneum; 2) reduces skin incision lengths (which can reduce analgesic use and may allow an earlier return to normal activities); 3) it allows a more limited ureteric mobilization at the time of anastomosis. Reductions in the time that intra-abdominal visceral contents are exposed to ambient air results in reduced surgical stress response and consequential advantages to patients.<sup>12, 13</sup> As reported by Ahmed *et al.*,<sup>11</sup> the percentage of gastrointestinal complications is higher in ECUD than in ICUD (23% vs. 10%,  $P < 0.001$ ). It has been demonstrated that the length of time the peritoneum is exposed to the air is proportional to the severity of intestinal inflammation, which may lead to intestinal paralysis or ileus.<sup>14</sup>

Another critical technical point is that performing a uretero-ileal anastomosis (UIA) outside the abdominal cavity requires a greater mobilization of ureters, which can lead to ischemic ureteric strictures or anastomotic leakage with subsequent fibrosis.<sup>15-17</sup> ICUD allows a more limited mobilization of ureters, which reduces the risk of these complications.

The main problem in performing an ICUD is the steeper learning curve and the technical challenges that lengthen operative times.<sup>18</sup> It has been suggested that the number of ICUD cases needed to reach an acceptable learning curve is 30,<sup>9</sup> but there is variation as regards how to define proficiency in this very particular field. Refining surgical techniques could shorten the learning curve and reduce postoperative complications (as documented by the inverse relationship between surgeon experience and operative complications).

The same considerations can be made regarding operative time: as documented by the analysis of large series, when proficiency is reached, there are no significant differences in comparisons between operative times for ileal conduit and neobladder ICUDs.<sup>19</sup>

### Intracorporeal urinary diversion

#### *Technical surgical considerations*

As recently stressed by Aaron *et al.*,<sup>20</sup> experience and acquired proficiency are needed for expeditious and efficient bowel work during robotic surgery. After RARC, a segment of bowel (mostly ileum) is used to create the conduit or neobladder. Exception include Goh *et al.*,<sup>21</sup> who use colon for reconstruction. A previously measured and marked Penrose drain, suture or a flexible ruler may be used to measure the segment of bowel to be used. As the recent Pasadena Consensus Panel<sup>22</sup> noted, there are various ways of manipulating the ileum safely. These include using robotic (soft) bowel graspers or sutures to facilitate handling. An example of the latter is the Marionette technique<sup>23</sup> in which a Keith needle is brought through the anterior abdominal wall, passed under the ileum, and then back out.

This stitch is controlled with an instrument allowing the distal end of the ileal segment to be raised and lowered, like a marionette, during the procedure. This technique is useful during the creation of an intracorporeal ileal conduit. In the case of an intracorporeal orthotopic neobladder, another way of manipulating the ileum safely is to pass two vessel loops round the intestine through the mesentery on both sides of the ileal loop section to be anastomosed to the urethra.

The final Pasadena document did not mention incising the mesentery. This is needed to create sufficient length and mobility for the bowel segment, but it is important to preserve vascular supply to the pedicle. Incision options include vascular staples to the bowel and adjacent mesentery or separate incision and vascular division. The latter is facilitated by fluorescence imaging to confirm its vascular anatomy (indocyanine green solution given intravenously for mesenteric angiography)<sup>24</sup> or white light. The LUCS technique (Lighting from Urethral Catheter Side)<sup>25</sup> has recently been proposed to determine the site of mesenteric bowel division: a flexible cystoscope is introduced through the urethra, and its light is used to identify the vessels transilluminating the mesentery.

The selected segment of ileum is then divided with Endo-GIA staplers. A technical tip during stapling is to hold the bowel opposite the stapler, using the robot's pincer to align the two bowel ends, and then gently push them against the side of the stapler itself, thus facilitating the maneuver.<sup>26</sup> In restoring bowel continuity, one technical tip is to use color-coded stay-sutures, which help to keep the transected bowel ends and various segments of the ileal loop properly oriented, or to mark the distal bowel with a stay suture prior to division.

Various modes for detubularization of ileal segments have been reported. One of the most efficient is to perform the incision on the anti-mesenteric side of the bowel segment using a tube, such as a lubricated chest tube, which keeps the bowel under tension and safeguards the posterior wall.<sup>19</sup>

## Types of intracorporeal urinary diversion

Several centers have reported their preliminary ICUD results.<sup>27</sup> As reported by the Pasadena Consensus Panel,<sup>22</sup> the distribution of urinary diversion types shows that ICUD is performed in less than 20% of RARC cases. Recent literature reports show that ICUD is increasingly performed, probably due both to increased robotic proficiency among urologists and to the development of reproducible techniques.<sup>28</sup>

Analyzing the stratification of ICUD types, the most interesting fact is that most of them involve ileal conduits (63%): this is probably due to the high-risk nature of the procedure required to create an ICUD, which in turn suggests that surgeons should choose to create an intracorporeal neobladder only in "ideal" patients. One concern is the influence of proficiency when the type of diversion is chosen: if urologists become proficient at intracorporeal ileal conduits, they may be influenced in advising a patient to accept incontinent diversion, although that patient might be a better candidate for a neobladder.

The choice between an incontinent ileal conduit and an orthotopic neobladder depends on both patient's and urologist's preferences, and these are important as regards the patient's quality of life and possible postoperative events. We would like to emphasize that the current EAU guidelines state that no level 1 evidence exists favoring one diversion type over another.<sup>29</sup>

Obviously, increasing the numbers of procedures performed leads to progressively reduced times: *e.g.*, in a series of 100 consecutive intracorporeally performed ileal conduits, Azzouni *et al.* reported a reduction in median diversion time (140-123 minutes,  $P=0.002$ ) between the first 25 and the last 25 cases.<sup>30</sup>

## Ileal conduit


The ileal conduit is the easiest and quickest way of performing an ICUD. Ahmed *et al.*<sup>11</sup> demonstrated that an intraoperative ileal conduit is superior to its extracorporeal

counterpart, in view of both of the readmission rate at 30 days (5% vs. 15%,  $P < 0.0001$ ) and the 90-day mortality rate (1.6% vs. 4.9%,  $P = 0.043$ ).

From the technical viewpoint, a 20-cm segment of ileum is isolated. Varying UIA experiences have been reported according to the Bricker (separate UIA) or Wallace (conjoined UIA) techniques, although no differences in terms of complications have been reported. The former technique seems to be more frequently used than the latter.

Examining the largest and most recent series reported in the literature, several modifications have been made to the technique used in the first few cases. For example, in order to reduce operative time, Azzouni *et al.*<sup>30</sup> abandoned irrigation of the conduit (without any significant increase in infectious complications); added a separate port to introduce the laparoscopic stapler, providing a direct passage to bowel segments and avoiding bowel rotation during restoration of ileal continuity; and changed the UIA technique (now made before re-establishing bowel continuity), which had initially been performed with simple interrupted stitches and later with a running technique.

In the technique reported by Canda *et al.*,<sup>31</sup> the left ureter is transposed to the right iliac gutter underneath the sigmoid colon. 15-20 cm of the ileal segment is segregated, sparing the most distal 20-cm segment of the terminal ileum adjacent to the cecum (Figure 1A). A side-to-side ileo-ileal anastomosis is performed with a laparoscopic bowel stapler (Figure 1B). A Wallace or Bricker type UIA is performed. Double-armed 3/0 polyglecaprons or barbed suture can be used (Figure 1C). Thereafter, single-J stents are introduced into the ureters (Figure 1D). UIA is completed (Figure 1E).

In order to emplace two ureteral stents, a wire is introduced through an assistant's laparoscopic port up to the ureters, and then a single-J or double-J catheter is set in place. To facilitate the positioning of wires, a nephrostomy puncture needle  be placed suprapubically at the **midline**; another possibility is to pass the wires through an open-ended urethral catheter.

The same modalities can be used in performing UIA in neobladder ICUD.

Lastly, UIA can be stabilized to the parietal peritoneum (Figure 1F).

### Continent cutaneous urinary diversion

Only a few cases involving an intracorporeal technique have been reported. Goh *et al.*<sup>21</sup> recently described a technique to create an intracorporeal right colonic catheterizable pouch, replicating step-by-step the principles of the open approach to create a hand-sewn colonic pouch. The application of open surgical techniques to create a continent robotic **catheterizable** urinary diversion still seems to be in a nascent phase.

### Neobladder

Ideal bladder substitution maintains low pressure during the filling phase and has high compliance with good continence. The reservoir should empty on voiding and protect the upper urinary tract.

Which is the robotically performed bladder substitute which meets all these requirements? Some existing techniques tested and used in open neobladder reconfigurations have been modified and adapted to robotic surgery.<sup>32</sup> Various procedures have been proposed and are currently used.

### Karolinska modified Studer neobladder<sup>33</sup>

The ileum is isolated in a J-configuration and an urethro-ileal anastomosis is performed. The ileum is detubularized and the posterior plate is closed. The anterior wall of the neobladder is folded to close the neobladder anteriorly with absorbable sutures. UIA is performed at the afferent limb in a Wallace fashion (Figure 2).

### University of Southern California modified Studer neobladder<sup>34</sup>

An isolated 44-cm segment of ileum is detubularized, 15 cm being preserved for the af-

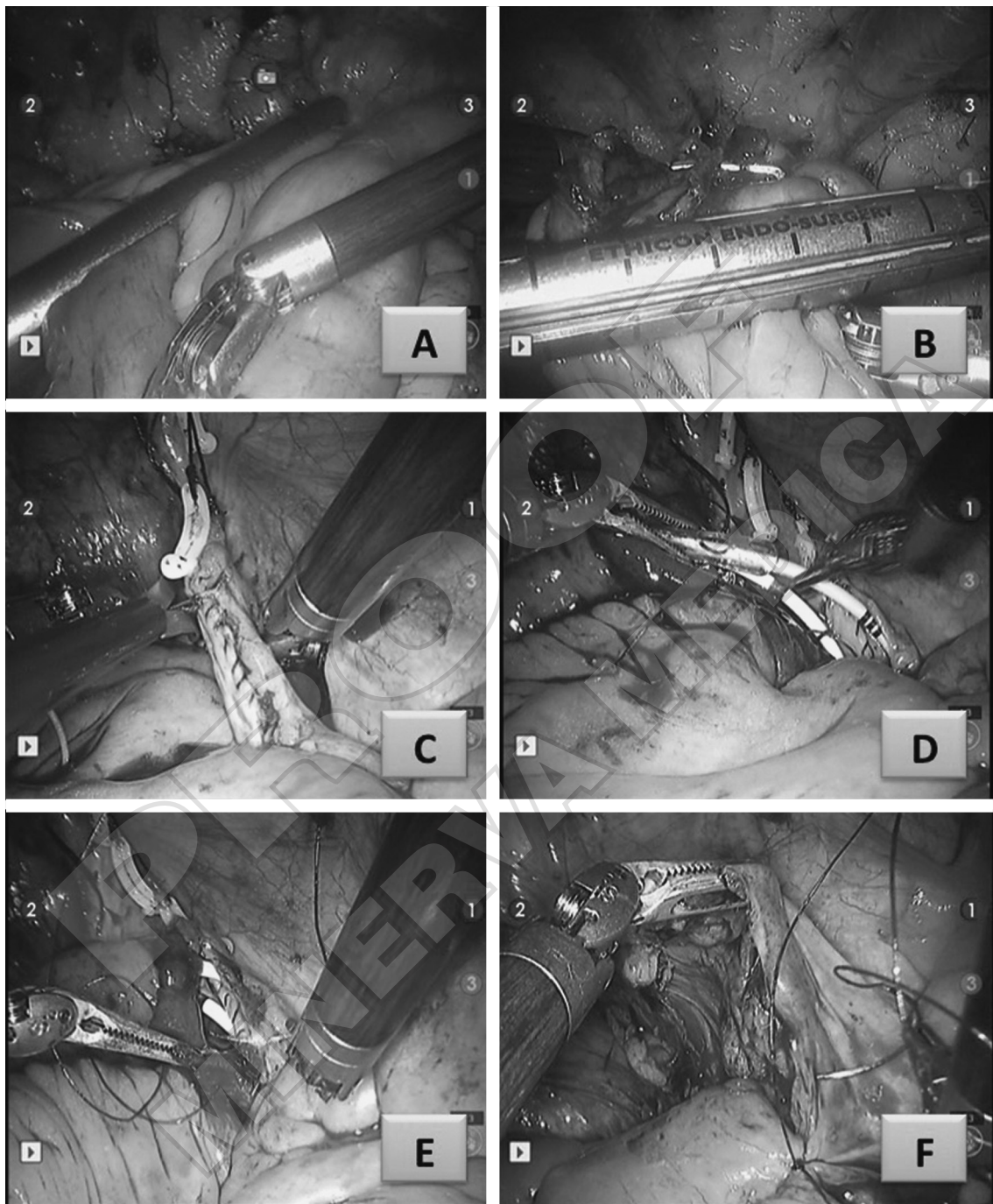


Figure 1.—A) Division of the ileal segments with laparoscopic bowel staplers; B) side-to-side ileo-ileal anastomosis by using laparoscopic bowel stapler; C) a Wallace type uretero-ureteral anastomosis; D) introduction of single-J into the ureters; E) uretero-ileal anastomosis; F) stabilization of the ureteroileal anastomosis by using the parietal peritoneum.

ferent limb. The posterior plate is closed with absorbable sutures and rotated 90° counter-clockwise. A urethro-ileal anastomosis is per-

formed and the anterior suture line is closed, followed by a UIA with the Bricker technique (Figure 3).

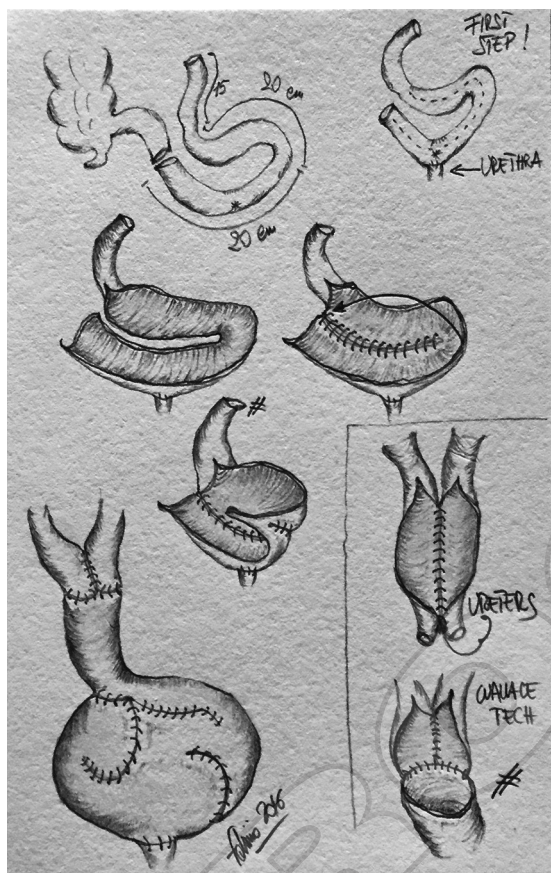


Figure 2.—Karolinska modified Studer neobladder.

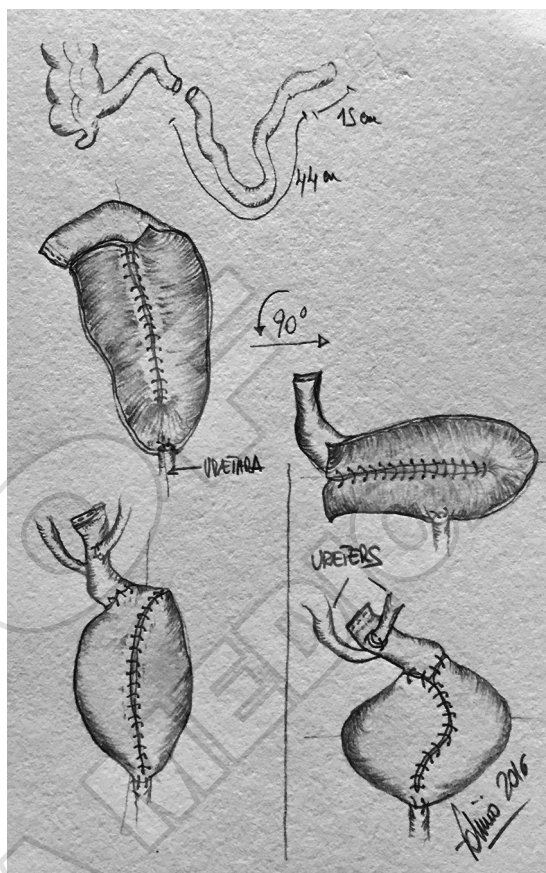


Figure 3.—University of Southern California modified Studer neobladder.

### Pyramid pouch<sup>35</sup>

Urethro-ileal anastomosis is performed, followed by detubularization of the ileum at its antimesenteric border. The posterior and anterior plates are then closed with absorbable sutures, and the folded edge of the neobladder is closed from lateral to medial. UIA is performed according to Bricker (Figure 4).

### Y-Pouch

A 40-cm ileal segment is isolated 15-20 cm proximal to the ileocecal valve, and a side-to-side entero-entero anastomosis is performed to re-establish bowel continuity. The isolated intestinal segment is arranged in a Y-shape, with two central 14-cm segments and two 6-cm limbs. The two central segments are brought

together and detubularized with two sequential firings of a mechanical stapler inserted through an opening made at the lowest point of the neobladder on its anti-mesenteric border. Then the Y-neobladder is anastomosed to the urethra (Figure 5).

Although this proved to be easier to perform than endoscopic intracorporeal urinary diversion, it must be regarded a retrograde step. The U-pouch, which is essentially the underlying principle, had to be abandoned many years ago, due to higher intraluminal pressure and the fear of long-term renal insufficiency. We have since gone back to the I-pouch<sup>35</sup> or, alternatively, the Studer pouch as the standard choices of urinary diversion. The I-pouch is a transversely folded 4-segment low-pressure reservoir made of 40-cm terminal ileum, into which the conjoined (Wallace-type) ureters are

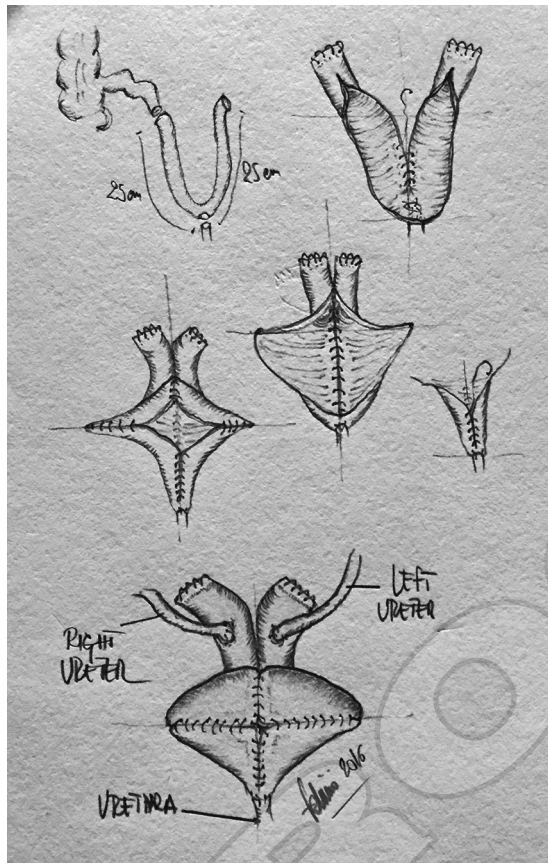


Figure 4.—Pyramid Pouch.

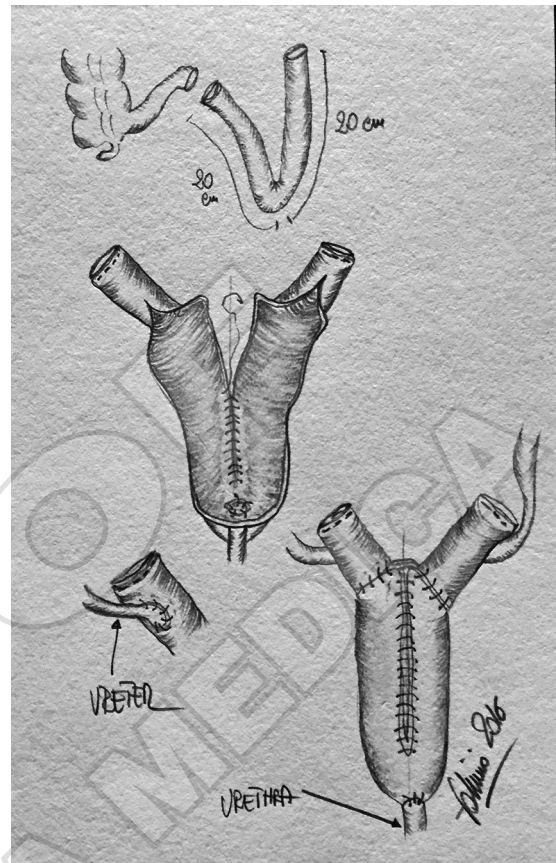


Figure 5.—Y-Pouch.

inserted through an anti-refluxive subserosal tunnel. This makes the ureteral orifices clearly visible on the dorsal side of the pouch for possible later upper urinary tract interventions.

#### Vescica ileale padovana<sup>36</sup>

The ileal segment is isolated and incised along its antimesenteric border, and a funnel is created inferiorly to promote drainage into a tension-free urethro-intestinal anastomosis. The proximal loop of the detubularized ileum is folded in a reverse “S” configuration and sutured on its sides to create an ileal cup. A is performed by direct urethral replantation: the ureter end is spatulated for an anastomosis, which is then stented. The anterior aspect of the neobladder is then folded downward and receives a running absorbable suture. Papalia

*et al.*<sup>37</sup> reported a median operative time (console time) of 4.2 h (range: 4-6) (Figure 6-left side).

A “Ves.Pa.” (lat. *Vesica Patavina*) modification (without the creation of the inferior funnel, with simplified double folding and with a chimney) has recently been proposed, to reduce operative times and maintain the basic principles of VIP (Figure 6-right side).<sup>38</sup>

#### Intracorporeal neobladder after Apex-preserving RARC<sup>39</sup>

Robotic assisted nerve-sparing cystoprostatectomy with prostatic apex-preservation should only be reserved for young men (<40 years old) with the diagnosis of urothelial carcinoma undergoing robotic assisted RC (RARC) with orthotopic neobladder formation.



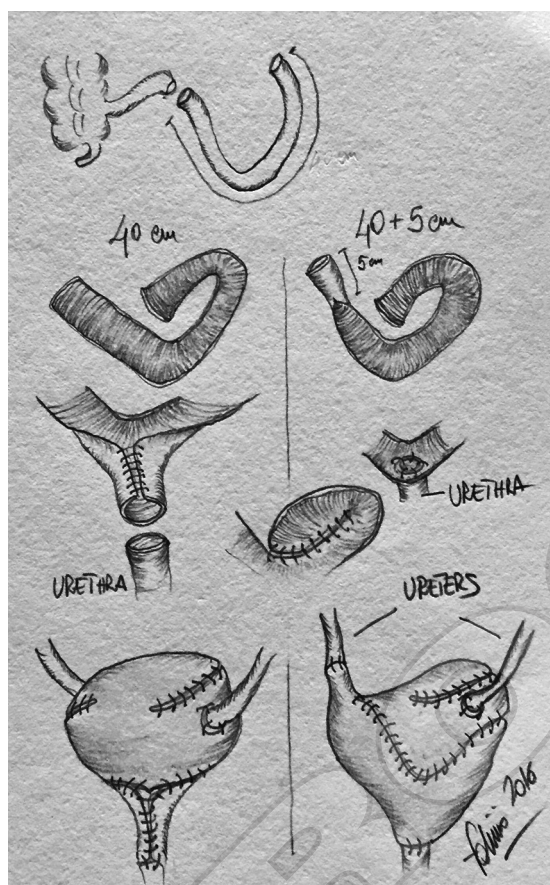


Figure 6.—Vesica Ileale Padovana on the left side. Vesica Patavina on the right side.

The technique of RARC is performed as previously described. The technical modification starts at the time of the bilateral intra-fascial nerve dissection which is completed in an antegrade fashion. The apical dissection starts just under the dorsal vein complex and through anterior prostatic fibromuscular stroma. This plane is further carried through the prostatic urethra and transecting the most caudal aspect of prostatic peripheral zone, leaving a long urethra and a posterior urethral plate formed by peripheral zone of the prostate serving as a robust, long stump for the subsequent vesicourethral anastomosis. Intracorporeal ileal neobaldder formation and urinary diversion is then performed as previously described.

Preservation of apical prostatic tissue allow for a long membranous urethral length.

The remnant prostatic apical tissue (anterior fibromuscular and peripheral zone) forms a robust plate for the subsequent urethrovesical anastomosis. The length preservation plays a pivotal role in time to recovery and degree of continence.

The preservation of cavernous nerve bundles during the procedure further assists with the subsequent recovery of urinary continence as well as the maintenance of erectile function.

Maximal urethral length preservation and nerve sparing, as well as the young age of patient are probably contributing factors toward excellent continence and erectile function outcomes.

### Other techniques

Many other techniques (e.g., involving U- or W-shapes) have been proposed, tested on animal models and performed, but the small number of cases reported does not allow accurate evaluation of their technical feasibility and functional outcomes.<sup>40</sup>

### Considerations

From a technical viewpoint, some key elements of all the above techniques must be examined:

— the choice of type of urinary diversion depends not only on the surgeon's preference, but also on the patient's characteristics and preferences. It must also be based on an honest analysis by the urologist of the balance between the benefits and risks for the patient, also considering the real expertise and skill of all the members of the dedicated robotic team. RARC represents a very good example of teamwork in which not only surgeons and nurses, but also anesthesiologists and all staff involved in perioperative care, contribute to the end-result.

This is why, for example, we need to define in advance clear-cut pre/perioperative protocols, such as ERAS (Enhance Recovery After Surgery).<sup>41</sup> ERAS is a multimodal care pathway that reduces the physiological impact of surgery and speeds post-operative recov-

ery. ERAS pathways start before surgery with encouragement of exercise and mobilization (prehabilitation), attention to diet (calorie intake) and reduction of risk factors (such as smoking). Postoperative care demands can be predicted using exercise thresholds (derived from Cardio pulmonary exercise testing [CPEX]). In the immediate pre-operative period there is an avoidance of unnecessary fasting and carbohydrate/fluid loading up to 2 hours prior to anesthesia. During surgery, ERAS principles include using small incisions or minimal invasive surgery, regional anesthesia (local blocks or epidural), hypotensive anesthesia and low blood losses, and avoidance of nasogastric tubes and pelvic drains. Post-operative ERAS steps include early mobilization (within 24 hours of surgery), incentivized exercise, thromboprophylaxis and early enteral nutrition.

As documented in many centers, surgeons often initially focus on performing ileal conduit ICUDs in order to gain experience of it and to standardize the technical aspects of bowel isolation and UIA, and then decide to start performing neobladder ICUDs only when confidence is gained.

— accurate preoperative planning of all surgical and technical steps is mandatory, with standardization of every minute and rigorous adherence to its plan during the intervention, avoiding as much as possible any deviation from the defined standard — not only to reduce the risk of complications, but also to improve the timing efficiency of this complex procedure;

— in the first part of the RARC/ICUD learning curve, we must also take into account the presence of a tutor/mentor, not only for surgical timings but also during preoperative planning;

— RARCs and ICUDs are high-stress interventions: the outcomes of this kind of surgery may be affected by non-technical factors, such as surgeon fatigue. One tip is to use a two-team approach (one team for the RARC and lymphadenectomy, and one for the ICUD), in order to avoid the negative impact of surgeon fatigue at the most dangerous moments of the operation;

— one of the most frequent complications encountered is the finding of benign ureteral strictures. Hautmann reported a rate of 11% in a very large series of ORCs with long-term follow-up.<sup>42</sup> Data available for RARC series are limited and underestimated, as such strictures represent long-term complications, perhaps for as many as 15 years: Tyrirtzys<sup>15</sup> reported 2.8% with a median follow-up of 30.3 months and, in a recent review of 203 patients with neobladder ICUD, Fahmy<sup>43</sup> reported 5.4%, with a median follow-up of 3 to 52 months. Strictures may result from ischemia due to injury of ureteral vascularity during dissection, or to technical errors during anastomoses. In any case, the percentage of ureteral strictures in ECUD cannot be compared with that in ICUD, since ECUD involves ureteral stretching due to extramobilization during reimplantation, which may lead to ischemic injury. Another difference is that evaluation of ICUD results shows that the length of ureters is more accurate than in ECUD, avoiding a redundancy which could cause kinking, or stretching of the ureteral wall while the pouch is being replaced in the pelvis, when a ureter has been excessively shortened.

Starting from historical data of ORC reporting, upper tract dilatation due to uretero-ileal stenosis in 13.5% of patients with antireflux nipple, compared with 3% of patients receiving the refluxing technique, in both ileal conduit and neobladder robotic ICUD, UIA is usually performed without an antireflux mechanism.<sup>44</sup>

The timing of UIA differs in several reported series: most authors<sup>45</sup> perform it at an early stage before pouch configuration, whereas only in a few centers (such as that of Butt)<sup>46</sup> is this step performed at the end of the configuration;

— another challenge is urethro-ileal anastomosis in neobladder. The critical step in isolating the appropriate ileal segment is careful identification of the most mobile loop of terminal ileum with the longest mesentery. Most conversions to extracorporeal diversion are in fact due to the inability to bring the ileum down to the urethra robotically, early in the learning curve. Using barbed sutures can minimize the risk of urinary leakage, allowing an

accurate approach and alignment of the ileum to the urethra;

— another key point is the suturing technique used. Although sutures (barbed or not) are used in most of the series reported in the literature, in order to minimize the risk of stone formation, in some cases reabsorbable staples are used. Ferriero *et al.*<sup>47</sup> demonstrated that the rate of stone formation is similar in stapled series and those with hand-sewn sutured reservoirs. It is important to globularize the neobladder perfectly, in order to create a low-pressure reservoir and to preserve both renal function and urinary continence;

— related to continence literature data demonstrates up to 90% of high, complete, day- and night-time continence. The high daytime rate suggests not only that RARC can adequately preserve the continence mechanism, but also that the urodynamic features of the neobladder seem to adhere to the functional and physical principles (Laplace's law) of "ideal" open reconstruction techniques. Recently Satkunasivam *et al.*<sup>48</sup> published their experience with ICUD with worse daytime wetness and continence with shorter follow-up, even though they showed similar high volume and low pressure reservoir either ICUD versus Open. It is important to consider in radical bladder surgery a careful dissection of the urethra to improve continence;<sup>49</sup>

— which kind of ICUD is more time-efficient? Collins showed that demonstrated that RARC with ileal conduit is faster than with neobladder ICUD (292 vs. 420 min).<sup>50</sup> Tyrirtzis reported a median operative time of 7 hours (4.4–12.6 hours) in the Karolinska experience,<sup>15</sup> and Azzouni *et al.*<sup>30</sup> reported a median time for ileal conduit of 123 minutes.

Comparing time-efficiency data (excluding the first cases of the learning curve), Desai analyzed the specific times for ICUD and demonstrated that ileal conduit is faster than neobladder ICUD (median time 92 vs. 194 min,  $P=0.0008$ );<sup>19</sup>

— so which kind of neobladder is preferable? Our opinion is that, whichever kind of pouch is created, both experience and the description of its features and quality should be

based on large-scale studies. Only analysis of robust data can allow intracorporeal reconstruction to be performed in non-tertiary centers.

Although standardization of techniques is mandatory for safe, efficacious and time-efficient intervention throughout the learning curve, further improvements in reconstructive techniques should be considered, to reduce intra/post-operative complications and improve long-term results.

## Conclusions

Although most urinary diversions carried out in conjunction with RARC are currently performed extracorporeally, reports are now emerging describing intracorporeal versions. The data are limited and it is difficult to compare the functional outcomes of the various approaches.

Only analysis of long-term follow-up data from large-scale homogeneous series can ascertain whether robotic intracorporeal urinary diversion is superior to other approaches. How long will it be before we can achieve bioengineered, 3D-printed urinary reservoirs?

## References

1. Shabsigh A, Korets R, Vora KC, Brooks CM, Cronin AM, Savage C, *et al.* Defining early morbidity of radical cystectomy for patients with bladder cancer using a standardized reporting methodology. *Eur Urol* 2009;55:164-74.
2. Bochner BH, Dalbagni G, Sjoberg DD, Silberstein J, Keren Paz GE, Donat SM, *et al.* Comparing Open Radical Cystectomy and Robot-assisted Laparoscopic Radical Cystectomy: A Randomized Clinical Trial. *Eur Urol* 2015;67:1042-50.
3. Desai MM, Gill IS. "The Devil Is in the Details": Randomized trial of robotic versus open radical cystectomy. *Eur Urol* 2015;67:1053-5.
4. 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;44:337-9.
5. Hautmann RE, Herr HW, Pruthi RS, Aron M. Robotic radical cystectomy--is the diversion the Achilles' heel? *J Urol* 2014;192:1601-3.
6. Smith AB, Raynor M, Amling CL, Busby JE, Castle E, Davis R, *et al.* Multi-institutional analysis of robotic radical cystectomy for bladder cancer: perioperative outcomes and complications in 227 patients. *J Laparoendosc Adv Surg Tech A* 2012;22:17-21.
7. 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;67:376-401.
8. Collins JW, Hosseini A, Sooriakumaran P, Nyberg T, Sanchez-Salas R, Adding C, *et al.* Tips and tricks for intracorporeal robot-assisted urinary diversion. *Curr Urol Rep* 2014;15:457-66.
  9. Hayn MH, Hussain A, Mansour AM, Andrews PE, Carpentier P, Castle E, *et al.* The learning curve of robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. *Eur Urol* 2010;58:197-202.
  10. Hautmann RE, de Petriconi RC, Volkmer BG. Lessons learned from 1,000 neobladders: the 90-day complication rate. *J Urol* 2010;184:990-4.
  11. Ahmed K, Khan SA, Hayn MH, Agarwal PK, Badani KK, Balbay MD, *et al.* Analysis of intracorporeal compared with extracorporeal urinary diversion after robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. *Eur Urol* 2014;65:340-7.
  12. Ost MC, Tan BJ, Lee BR. Urological laparoscopy: basic physiological considerations and immunological consequences. *J Urol* 2005;174:1183-8.
  13. Knox ML, El-Galley R, Busby JE. Robotic versus open radical cystectomy: identification of patients who benefit from the robotic approach. *J Endourol* 2013;27:40-4.
  14. Tan S, Yu W, Lin Z, Chen Q, Shi J, Dong Y, *et al.* Peritoneal air exposure elicits an intestinal inflammation resulting in postoperative ileus. *Mediators Inflamm* 2014;924296:1-11.
  15. Tyrirtzis SI, Hosseini A, Collins J, 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.
  16. Yuh BE, Nazmy M, Ruel NH, Jankowski JT, Menchaca AR, Torrey RR, *et al.* Standardized analysis of frequency and severity of complications after robot-assisted radical cystectomy. *Eur Urol* 2012;62:806-13.
  17. Anderson CB, Morgan TM, Kappa S, Moore D, Clark PE, Davis R, *et al.* Ureterointer anastomotic strictures after radical cystectomy--does operative approach matter? *J Urol* 2013;189:541-7.
  18. Kang SG, Ko YH, Jang HA, Kim J, Kim SH, Cheon J, *et al.* Initial experience of robot-assisted radical cystectomy with total intracorporeal urinary diversion: comparison with extracorporeal method. *J Laparoendosc Adv Surg Tech* 2012;22:456-62.
  19. Desai MM, de Abreu AL, Goh AC, Fairey A, Berger A, Leslie S, *et al.* Robotic intracorporeal urinary diversion: technical details to improve time efficiency. *J Endourol* 2014;28:1320-7.
  20. Aron M, Gill IS. Robotic radical cystectomy: so far, so good--what next? *Eur Urol* 2015;67:361-2.
  21. Goh AC, Aghazadeh MA, Krasnow RE, Pastuszak AW, Stewart JN, Miles BJ. Robotic Intracorporeal Continent Cutaneous Urinary Diversion: Primary Description. *J Endourol* 2015;29:1217-20.
  22. Chan KG, Guru K, Wiklund P, Catto J, Yuh B, Novara G, *et al.* Robot-assisted radical cystectomy and urinary diversion: technical recommendations from the Pasadena Consensus Panel. *Eur Urol* 2015;67:423-31.
  23. Guru K, Seixas-Mikelus SA, Hussain A, Blumenfeld AJ, Nyquist J, Chandrasekhar R, Wilding GE. Robot-assisted intracorporeal ileal conduit: Marionette technique and initial experience at Roswell Park Cancer Institute. *Urology* 2010;76:866-71.
  24. Manny TB, Hemal AK. Fluorescence-enhanced robotic radical cystectomy using unconjugated indocyanine green for pelvic lymphangiography, tumor marking, and mesenteric angiography: the initial clinical experience. *Urology* 2014;83:824-9.
  25. Dal Moro F, Zattoni F. Lighting from the urethral cystoscope side: A novel technique to safely manage bowel division during intracorporeal robotic urinary diversion. *Int J Urol* 2016;23:344-5.
  26. Janda GM, Woods ME, Pruthi RS. Practical tips for safe and efficient robotic cystectomy. *Curr Urol Rep* 2015;16:37.
  27. 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;67:402-22.
  28. Chopra S, Abreu AL, Gill IS. Robotic urinary diversion: the range of options. *Curr Opin Urol* 2016;26:107-13.
  29. Witjes JA, Compérat E, Cowan NC, De Santis M, Gakis G, Lebre T, *et al.* EAU guidelines on muscle-invasive and metastatic bladder cancer: summary of the 2013 guidelines. *Eur Urol* 2014;65:778-92.
  30. Azzouni FS, Din R, Rehman S, Khan A, Shi Y, Stegmann A, *et al.* The first 100 consecutive, robot-assisted, intracorporeal ileal conduits: evolution of technique and 90-day outcomes. *Eur Urol* 2013;63:637-43.
  31. Candà 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.
  32. Goh AC, Gill IS, Lee DJ, de Castro Abreu AL, Fairey AS, *et al.* Robotic intracorporeal orthotopic ileal neobladder: replicating open surgical principles. *Eur Urol* 2012;62:891-901.
  33. 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;30:307-13.
  34. Abreu AL, Chopra S, Azhar RA, Berger AK, Miranda G, Cai J, *et al.* Robotic radical cystectomy and intracorporeal urinary diversion: The USC technique. *Indian J Urol* 2014;30:300-6.
  35. Tan WS, Sridhar A, Goldstraw M, Zacharakis E, Nathan S, Hines J, *et al.* Robot-assisted intracorporeal pyramid neobladder. *BJU Int* 2015;116:771-9.
  35. Gakis G, Abdelhafez MF, Stenzl A. The "I-Pouch": Results of a new ileal neobladder technique. *Scand J Urol* 2015;49:400-6.
  36. Pagano F, Artibani W, Ligato P, Piazza R, Garbeglio A, Passerini G. Vescica Ileale Padovana: a technique for total bladder replacement. *Eur Urol* 1990;17:149-54.
  37. Papalia R, Guaglianone S, Mastroianni M, Ferriero M, Simone G, Gallucci M. Totally intracorporeal robot-assisted Vescica Ileale Padovana (VIP): A step by step technique. *Eur Urol Suppl* 2014;13:1-60.
  38. Dal Moro F, Zattoni F. Ves.Pa. - Designing a Novel Robotic Intracorporeal Orthotopic Ileal Neobladder. *Urology* 2016;91:99-103.
  39. Nyame YA, Zargar H, Ramirez D, Ganesan V, Babbar P, Villers A, *et al.* Robotic-assisted laparoscopic bilateral nerve sparing and apex preserving cystoprostatectomy in young men with bladder cancer. *Urology* 2016;94:259-64.
  40. Kurpad R, Woods M, Pruthi R. Current Status of Robot-Assisted Radical Cystectomy and Intracorporeal Urinary Diversion. *Curr Urol Rep* 2016;17:42.
  41. 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 [Epub ahead of print].

42. Hautmann S, Chun KH, Currllin E, Braun P, Huland H, Juenemann KP. Refluxing chimney versus nonrefluxing LeDuc ureteroileal anastomosis for orthotopic ileal neobladder: a comparative analysis for patients with bladder cancer. *J Urol* 2006;175:1389-93.
43. Fahmy O, Asri K, Schwentner C, Stenzl A, Gakis G. Current status of robotic assisted radical cystectomy with intracorporeal ileal neobladder for bladder cancer. *J Surg Oncol* 2015;112:427-9.
44. Studer UE, Danuser H, Thalmann GN, Springer JP, Turner WH. Antireflux nipples or afferent tubular segments in 70 patients with ileal low pressure bladder substitutes: long-term results of a prospective randomized trial. *J Urol* 1996;156:1913-7.
45. Tan WS, Sridhar A, Ellis G, Lamb B, Goldstraw M, Nathan S, *et al.* Analysis of open and intracorporeal robotic assisted radical cystectomy shows no significant difference in recurrence patterns and oncological outcomes. *Urol Oncol* 2016;34:257.e1-9.
46. Butt ZA, Forbes E, Zorn J, Martin BS. Robotic radical cystectomy with intracorporeal neobladder: Initial experience and outcomes. *Can Urol Assoc J* 2015;9:E156-9.
47. Ferriero M, Guaglianone S, Papalia R, Muto GL, Gallucci M, Simone G. Risk assessment of stone formation in stapled orthotopic ileal neobladder. *J Urol* 2015;193:891-6.
48. Satkunasivam R, Santomauro M, Chopra S, Plotner E, Cai J, Miranda G, *et al.* Robotic Intracorporeal Orthotopic Neobladder: Urodynamic Outcomes, Urinary Function, and Health-related Quality of Life. *Eur Urol* 2016;69:247-53.
49. Walz J, Burnett AL, Costello AJ, Eastham JA, Graefen M, Guillonneau B, *et al.* A critical analysis of the current knowledge of surgical anatomy related to optimization of cancer control and preservation of continence and erection in candidates for radical prostatectomy. *Eur Urol* 2010;57:179-92.
50. Collins JW, Tyritzis 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;64:654-63.

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