Robot-assisted intracorporeal orthotopic bladder substitution after radical cystectomy: perioperative morbidity and oncological outcomes – a single-institution experience

Abolfazl Hosseini1, Ashkan Mortezavi1,2, Siri Sjöberg1, Oscar Laurin1, Christofer Adding1, Justin Collins1,3 and Peter N. Wiklund1,4

1Department of Molecular Medicine and Surgery, Section of Urology, Karolinska Institutet, Stockholm, Sweden, 2Department of Urology, University Hospital Zurich, University of Zurich, Zurich, Switzerland, 3Department of Urology, UCLH, London, UK, and 4Department of Urology, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Objective
To report a single-institution experience with totally intracorporeal neobladder urinary diversion (UD) after robot-assisted laparoscopic radical cystectomy (RARC).

Patients and methods
A total of 158 patients underwent totally intracorporeal neobladder UD after RARC between 2003 and 2016. Patient demographics, intraoperative and pathological data, 30- and 90-day perioperative mortality and complications were recorded. Complications were classified according to the modified Clavien-Dindo classification. The 5-year overall (OS) and cancer-specific survival (CSS) rates were estimated by Kaplan-Meier plots.

Results
Most of the patients were male (84%) and had clinical T Stage ≤2 (87%). The mean operation time was 359 (SD ±98) min, with a median (range) estimated blood loss of 300 (50–2200) mL. Most of the men (86%) received a nerve-sparing procedure and 38% of the females an organ-sparing approach. A lymph node dissection was performed in 156 (99%) patients, with a median (range) yield of 23 (7–48) nodes. Conversion to open surgery occurred in five patients (3%). We recorded negative margins in 156 patients (99%). The median (range) follow-up was 34 (1–170) months, with 30- and 90-day mortality rates of 0%. Clavien–Dindo Grade III-IV complications occurred in 29 of 158 (18%) patients at 30-days and in eight of 158 (5%) between 30–90 days, resulting into a 90-day overall high-grade complication rate of 23%. The unadjusted estimated 5-years recurrence-free survival, CSS and OS rates were 70%, 72%, and 71%, respectively.

Conclusion
In our present series the complication and oncological results were similar to open RC series, suggesting that RARC followed by totally intracorporeal neobladder UD is a safe and feasible alternative.

Keywords
bladder neoplasm, cystectomy, urinary diversion, ileal neobladder, intracorporeal, robotic surgical procedures, complications
and in 50% in European centres, respectively [1]. While an extracorporeal UD (ECUD) after RARC was traditionally preferred by most surgeons (hybrid approach), increasing expertise led to a broader utilisation of intracorporeal UD (ICUDs), aiming to maximise the advantages of the minimally invasive approach. In a report by the International Robotic Cystectomy Consortium the proportion of ICUDs increased from 9% in 2005 to 97% in 2015 in centres that were performing RARC. This increase was predominantly observed for intracorporeal ileal conduits, with a rate increase from 2% to 81%; and to a much lesser degree for intracorporeal continent neobladders, with a rate increase from 7% in 2005 to 17% in 2016 [2]. Despite more centres offering these procedures as an alternative to ORC, there is little published data on perioperative morbidity and long-term oncological outcomes, especially for RARC with totally intracorporeal neobladder UD. In the present study, we report complications and oncological outcomes from a large cohort of patients who underwent RARC with totally intracorporeal neobladder UD at our tertiary referral centre.

### Patients and methods

Between December 2003 and December 2016, 475 patients underwent RARC at our institution. A total of 158 patients were identified who received an orthotopic neobladder. All procedures were performed by two surgeons (P.N.W., A.H.) who had prior experience with ORC. RARC with the formation of a modified Studer ileal neobladder was completed according to our previously reported surgical technique [3]. We used the standard da Vinci® robotic system (Intuitive Surgical, Sunnyvale, CA, USA) for the first 20 and the da Vinci Si system for the remaining 138 patients. A unilateral or bilateral nerve-sparing procedure was performed in male patients based on age, preoperative potency status, location and stage of the bladder tumour. Since 2012 we have implemented an enhanced recovery protocol (ERP) after RC in our clinic [4]. A full description of the ERP and timings can be seen in Table S1.

Data collection was performed prospectively for preoperative characteristics [age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, clinical T Stage, BCG instillation or neoadjuvant chemotherapy], operative variables [nerve-sparing, organ-sparing in females, operation time (skin-to-skin), PLND, conversion rate, estimated blood loss (EBL)], and postoperative outcomes (final pathology, lymph node yield, lymph node invasion and hospital stay) including complications. In detail, we assessed complications graded according to the modified Clavien–Dindo system [5] and reoperation rates at 30- and 90-days postoperatively.

A first follow-up visit, performed by specialised nurses, included routine laboratory work and scheduled at 2 and 4 weeks after RARC. A follow-up visit performed by a Urologist including physical examination was scheduled at 8 weeks, a renal scintigraphy at 12 weeks, and contrast-enhanced CT at 16 weeks after RARC. Thereafter, the patients were generally seen 3-monthly for the first 6 months postoperatively and then yearly for clinical assessment and contrast-enhanced CT as part of the oncological follow-up. In cases of clinical suspicion imaging was performed outside of this schedule. Survival times were defined as the time elapsed from RARC to the date of recurrence [recurrence-free survival (RFS)], death [overall survival (OS)] or death of bladder cancer [cancer-specific survival (CSS)]. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS®), version 25 (SPSS Inc., IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarise the data. Survival was estimated with the Kaplan–Meier method stratified for Stages. To evaluate the changes in operation time as an effect of a learning curve, the 158 consecutive cases were divided into four groups for comparison of means by Wilcoxon Mann–Whitney test.

### Results

A total of 158 patients undergoing RARC with totally intracorporeal neobladder UD were included in this analysis. The preoperative variables of the study population that were assessed are described in Table 1A. Most of the patients were male (84%) and had clinical T Stage ≤2 (87%). BCG or neoadjuvant chemotherapy prior to the surgery had been administered in 35 (22%) and 70 (44%) patients, respectively. Conversion to open surgery occurred in five patients (3%), exclusively because of technical problems during reconstruction of the UD. The mean operation time was 359 (SD ±98) min, with most of the men (86%) receiving a nerve-sparing procedure. Except in two patients, all other patients underwent PLND. For the intraoperative variables assessed see Table 1B. On final pathology no residual tumour was found in 41% of the specimens (T0); organ-confined (T1, Ta, T1–2) and non-organ-confined disease (T3–4) were reported in 41% and 18% of patients, respectively (Table 2). Concomitant prostate cancer was detected in 55 of 134 male patients (41%); the vast majority (95%) had a Gleason score of ≤7, with five patients (9%) in the cohort showing positive surgical margins (PSMs). The median (range) follow-up was 34 (1–170) months; 30-day mortality was available for the entire cohort, while only a single patient was lost to follow-up for the 90-day mortality analysis.

Intraoperative high-grade complications occurred in three (1.9%) patients. Two men developed a compartment syndrome of the lower leg. These patients had a BMI of 27 and 33 kg/m², EBL of 600 and 1800 mL, and an operation time of 570 and 345 min. A fasciotomy of the lower leg was performed in both patients. One patient was affected by a posterior infarction of optic nerve (PION) perioperatively and
was blind after the surgery. The console time in this patient was 370 min and the EBL 400 mL. Records excluded any episode of hypotension during the entire procedure. The vision did not recover.

A total of 115 complications were registered in the first 30 days after surgery (early, Table 3). Of these, 80 were considered as low-grade (Clavien–Dindo Grade I–II) and 35 as high-grade (Clavien–Dindo Grade IIIa–IV). On a per-patient basis, 71 (45%) and 29 (18%) had low- and high-grade early complications, respectively.

Between 30 and 90 days after surgery, 41 complications were registered (late, Table 4). Of these, 31 were considered as low-grade and 10 as high-grade. On a per-patient basis, 30 (19%) and eight (5%) had low- and high-grade late complications, respectively. All complications and their management are listed in detail in Tables 3 and 4. Particularly, UTIs were the most common complications in the first 90 days. Postoperative arterial bleeds originated from the internal or external iliac artery. Management was dependent on haemodynamic status; stable patients were managed by angiography, while instable patients underwent laparotomy. The four patients receiving nephrostomies due to hydronephrosis in the early postoperative period (Table 3) were treated either with balloon dilatation (one patient) or ureter re-implantation (three). All eight patients with ureterointestinal anastomosis leakage were managed by nephrostomies and did not develop any clinically relevant strictures during follow-up. Urolithiasis (three patients) occurred exclusively in the first patients of the series due to stapler usage for neobladder formation.

The re-operation rates (intervention requiring general anaesthesia, Clavien–Dindo Grade IIIb) at 30 and 90–90 days after RARC with a totally intracorporeal neobladder UD were 5% (eight patients) and 5% (eight), respectively. No patient died throughout the entire time period of 90 days postoperatively. The 30- and 90-day mortality rates were therefore reported to be 0%.

During the follow-up 26 patients (16%) had tumour recurrence in 41 different sites (Table 2). The most common localisations were pelvic-abdominal lymph nodes followed by pelvis, bone, liver, lung, and brain. Two patients (1.2%) had peritoneal carcinomatosis during the follow-up.
Figure 1 shows Kaplan–Meier survival plots for RFS, CSS, and OS. The unadjusted estimated survival rates at 60 months were 70%, 72%, and 71%, respectively. Adjusting for risk groups, the RFS, CSS and OS rates were 78%, 77%, and 76% for T0–T2; and 79%, 79% and 79% for N0 disease at 60 months, respectively.

Finally, an evaluation of the learning curve based on the duration of the procedure was performed. A consequent and significant reduction in the mean (SD) operation time was observed from a baseline of 479 (102) min for the first 40 cases to 385 (76) min (case 41–80), 326 (65) min (case 81–120), and finally to 328 (51) min for the last 40 cases of this series (first 40 vs last 40: \( P < 0.001 \)).

**Discussion**

Despite the increasing use of RARC followed by intracorporeal ileal conduit, the majority of centres prefer either an open approach or a hybrid approach of RARC and ECUD when it comes to orthotopic continent UDs. Totally ICUD is considered a challenging procedure with a longer operation time and learning curve, leading to justified concerns about the time efficiency compared with an open approach. Therefore, experience in totally intracorporeal neobladder UD and available data regarding perioperative outcomes are very limited [6]. In the present study, we present our single-centre experience of a large cohort of totally intracorporeal neobladder UD with a favourable perioperative outcome and acceptable operation time.

The creation of a UD after RARC is considered the most challenging part of the surgical procedure and most complications associated with RARC are related to the UD. Prior reports including a recent meta-analysis [7] have found no difference in 90-day high-grade complication rates between ORC and RARC. However, most of these studies are limited to ECUD in the robotic arm [7–9] or included <70

---

**Table 3 Complications at <30 days.**

| Complication                      | Events, \( n \) | Treatment                             | Clavien–Dindo Grade |
|-----------------------------------|-----------------|---------------------------------------|---------------------|
| Clavien grade <III                | 80              | Antibiotics                           | II                  |
| Clavien grade ≥IIIa               | 35              | Drain and antibiotics                 | IIIa                |
| **(a) Infection**                 |                 |                                       |                     |
| 1. UTI                            | 38              | ICU, antibiotics                      | IVa                 |
| 2. Intra-abdominal abscess        | 4               | Antibiotics                           | II                  |
| 3. Septicaemia                    | 3               | Antibiotics                           | II                  |
| 4. Unknown fever                  | 3               | Antibiotics                           | II                  |
| 5. Pyelonephritis                 | 2               | Antibiotics                           | II                  |
| 6. Infected lymphocele/haematoma  | 3               | Antibiotics                           | II                  |
| **(b) Gastrointestinal**          |                 |                                       |                     |
| 1. Paralytic ileus                | 11              | Natrium bicarbonate                   | II                  |
| 2. Metabolic acidosis             | 1               | Triple treatment                      | II                  |
| 3. Duodenal ulcer                 | 1               | Coagulation via gastroscopy           | IIIa                |
| 4. GI-bleeding                    | 1               | Laparotomy                            | IIIb                |
| 5. Bowel anastomosis leakage      | 1               | Laparotomy                            | IIIb                |
| 6. Obstructive ileus              | 1               | Laparotomy                            | IIIb                |
| **(c) Genitourinary tract**       |                 |                                       |                     |
| 1. Catheter obstruction (neobladder) | 2           | Irrigation                            | II                  |
| 2. Urethroenteric anastomosis leak| 7               | Catheterisation                       | II                  |
| 3. Hydronephrosis                 | 4               | Nephrostomy                           | IIIa                |
| 4. Ureteroenteric anastomosis leakage | 8         | Nephrostomy                           | IIIa                |
| **(d) Bleeding**                  |                 |                                       |                     |
| 1. Anaemia                        | 7               | Blood transfusion                     | II                  |
| 2. Arterial bleeding              | 2               | Endovascular coding                  | IIIa                |
| 3. Arterial bleeding              | 2               | Laparotomy                            | IIIb                |
| **(e) Wound**                     |                 |                                       |                     |
| 1. Wound infection                | 1               | Antibiotics                           | II                  |
| 2. Compartment syndrome           | 2               | Fasciotomy                            | IIIb                |
| 3. Wound dehiscence               | 2               | Laparotomy                            | IIIb                |
| 4. Open wound after fasciotomy    | 2               | Suture in LA                          | IIIa                |
| **(f) Cardiac**                   |                 |                                       |                     |
| 1. Arrhythmia                     | 2               | Medication                            | II                  |
| 2. Atrial fibrillation            | 1               | Defibrillation                        | IIIa                |
| 3. Myocardial infarction          | 1               | ICU                                   | IVa                 |
| **(g) Thromboembolic**            |                 |                                       |                     |
| 1. Deep vein thrombosis           | 1               | Anticoagulant                         | II                  |
| 2. Pulmonary embolism             | 1               | Anticoagulant                         | II                  |
| **Others**                        |                 |                                       |                     |
| PION                              | 1               | None                                  | IVa                 |

ICU, intermediate care unit; L.A, local anesthesia.
ICUD cases [10–13]. Although a recent analysis of the International Robotic Cystectomy Consortium observed an increased incidence of complications for ICUD vs ECUD (high-grade, 13% vs 10%, $P = 0.02$) [2], this rate decreased constantly by 2% per year and was lower than for ECUD at the study end in 2015 (6% vs 14%). Indeed, we also observed

**Table 4** Complications at 30–90 days.

| Complication                               | Event, n | Treatment                      | Clavien-Dindo Grade |
|--------------------------------------------|----------|--------------------------------|---------------------|
| Clavien grade $<$III                      | 31       |                                |                     |
| Clavien grade $\geq$IIIa                  | 10       |                                |                     |
| (a) Infection                              |          |                                |                     |
| 1. UTI                                     | 20       | Antibiotics                    | II                  |
| 2. Pyelonephritis                          | 4        | Antibiotics                    | II                  |
| 3. Abscess                                 | 1        | Drain + antibiotics            | IIIa                |
| 4. Wound infection                         | 1        | Antibiotics                    | II                  |
| (b) Genitourinary                          | 8        |                                |                     |
| 1. Stone in neobladder                     | 3        | Lithotripsy                    | IIIb                |
| 2. Distal ureter stricture                 | 3        | Balloon dilatation             | IIIa                |
| 3. Distal ureter stricture                 | 3        | Re-implantation                | IIIb                |
| 4. Fistula between neobladder and iliac artery | 1          | Surgery                        | IIIb                |
| (c) Gastrointestinal                       | 5        |                                |                     |
| 1. Constipation                            | 1        | Laxantia                       | II                  |
| 2. Paralytic ileus                         | 1        | Contrast barium                | II                  |
| 3. Obstructive ileus                       | 1        | Laparotomy                     | IIIb                |
| 4. Metabolic acidosis                      | 2        | Rehydrating + sodium bicarbonate | II            |
| (d) Thromboembolic                         | 2        |                                |                     |
| 1. Deep vein thrombosis                    | 1        | Anticoagulant                  | II                  |
| 2. Pulmonary embolism                      | 1        | Anticoagulant                  | II                  |

**Fig. 1** Kaplan–Meier plots for RFS, CSS, and OS: (a) unadjusted; adjusted for (b) pT stage and (c) pN stage.
more high-grade complications in the beginning of our present series, with a subsequent decline in the rate (data not shown). If the effects of the learning curve are taken into account, ICUD has potential benefits [2]; the obvious advantages of the totally intracorporeal technique are the protection of bowel inside the abdomen, reduced hypothermia and loss of fluids through dehydration, less bleeding, no need for extensive ureteric dissection, which may cause ureteric strictures, and minimal surgical trauma [14,15], leading to reduced complication rates and a quicker return of bowel function, as was recently shown in a large cohort of patients [16].

When it comes to complications after totally intracorporeal neobladder UD, predominantly case series or cohorts with small sample sizes have been reported [17–28]. The lowest rates for high-grade complications were reported from Japan [22] and France [17] with 4.5% and 7.5%, respectively. However, these patients were highly selected in terms of age and only harboured unilateral clinically organ-confined non-bulky tumours. Therefore, these results were in contrast to rates reported by other groups ranging between 25.0% and 27.5% [18,19,23,24,26,28]. Our 90-day high-grade complication rate of 24% is consistent with these studies and large (n >1000) open series in experienced centres [29]. Patients undergoing totally intracorporeal neobladder UD in our present cohort had a lower rate of gastrointestinal complications (n = 24, 15.2%) at 90 days compared to reported rates of 29.3% and 35.7% for ECUD and ORC, respectively [16]. Notably, the high-grade complication rate for gastrointestinal events demanding an intervention under anaesthesia was only 2.5%, which may be attributed to protection of the bowel inside the abdomen with the intracorporeal technique. Additionally, the use of ERP with RARC utilising ICUD techniques have been shown to improve patient recovery compared to traditional perioperative management [4,30]. After implementing an ERP in our department we could previously report comparable complication rates despite worsening demographics [4] and achieve a median hospitalisation time of only 8 days for totally intracorporeal neobladder UD, which in considerably shorter than the reported 15–24 days of historic open cohorts [31,32].

The question has been raised whether RARC negatively impacts survival outcomes, potentially due to increased rates of positive surgical margins, lower lymph node yields or alteration of recurrence patterns due to ‘tumour seeding’ linked to the pneumoperitoneum or insufflation [33]. However, growing evidence supports the non-inferiority of RARC in terms of oncological outcome [24,34]. Particularly in totally intracorporeal neobladder UD incomplete resection at the urethra or prolonged surgery time are concerns with potential impact on oncological outcome. In the present study, the PSM rate (1%) was lower than in the literature [35] and confirms that an enhanced sparing of the urethra for orthotopic bladder replacement can safely be performed with a minimally invasive approach. Furthermore, our median lymph node yield of 23 was higher than the recommended 9–16 [36] and showed that the prolonged procedure time did not impact the extent of the PLND. These favourable results for the early oncological indicators transferred to estimated 5-year RFS rates in our present cohort of 70% for all, 78% for ≤pT2, and 79% for N0, which are comparable or superior to previously reported ‘gold standard’ ORC (68%, 80%, and 78%) [37] and RARC series (61%, 78%, and 70%) [38]. Notably, only two patients (1.2%) developed peritoneal carcinomatosis (a dreaded recurrence site after RARC) and one (0.6%) at the prostatic urethra during follow-up. Pelvic abdominal lymph nodes were the most common site of recurrence, which is consistent with the distribution of recurrences seen in previous studies of ORC and in autopsy series [33]. Looking at the hard endpoints of CSS and OS, our rates after totally intracorporeal neobladder UD (72% and 71%) are comparable with previous single and large multicentre ORC (57–75% and 48–62%) and RARC series (71% and 52%) [38], demonstrating the oncological safety of our approach. The better OS rate in the present study is most likely related to a selection bias based on the chosen diversion type (younger and healthier patients).

Prolonged operation time has always been a concern with RARC, ICUD, and especially for totally intracorporeal neobladder UD. High-volume centres, including ours, have reported a stepwise reduction of operation time with improved outcomes, introducing a step-by-step standardised technique [39]. However, nerve-sparing RARC in males, organ-sparing RARC in females, and extended PLNDs combined with totally intracorporeal neobladder UD are factors that significantly affect operation time. In the present cohort, we performed nerve-sparing in a majority of males (86%) and organ-sparing RARC in more than a third (38%) of the female patients. Furthermore, an extended PLND was performed in 73% of all patients. Despite these, our average operation time was acceptable and we observed a significant reduction during the study period, reaching a plateau of ~5 h after the first 80 cases. Operation times reported by other series range between 305 and 493 min [17–20,22,23,26,28]; However, in most series >420 min were needed, which is significantly longer than the mean overall operation time of our present series (359 min).

Some of the perioperative complications may be directly related to operation time. A long operation time is a known predictive factor for compartment syndrome [40]. While one of the patients in the present cohort having this complication had indeed a longer than average operation time of 490 min, the second case was completed in 345 min, which is below average. Likewise, the patient with PION had a not exceptional operation time of 370 min. Quddus et al. [41]
reported two cases of PION; one case after RARC with ileal conduit and one in a patient with severe pancreatitis and multi-organ insufficiency. Although the exact cause of the development of PION is unclear, a combination of perioperative risk factors such as profound anaemia, hypotension, increased orbital venous pressure, prolonged operation time, and the steep Trendelenburg position in robotic pelvic surgery are postulated to contribute in susceptible individuals with cardiovascular risk factors [42,43]. Although surgery time and Trendelenburg position were lower than in the average patient in this case, they cannot be ruled out as contributing factors and awareness by surgeons and anaesthesiologists for this significant complication is recommended.

Our present study is not without limitations. First, it is a retrospective study. Furthermore, selection bias based on our learning curve should be considered when analysing our present results. With increasing experience, more bulky tumours have been included, and due to the large sample size, this effect may be smaller than in other reported series. Finally, the follow-up time was limited; one patient was lost to follow-up after 30 days and therefore data were not available for the 90-day mortality assessment. A median follow-up of 34 months may miss some of the metabolic complications.

In the present large single-centre series of totally intracorporeal neobladder UD, the complication and oncological outcome results were similar to large ORC series, with an acceptable operation time, suggesting that our approach is a safe and feasible alternative.

Conflict of Interest
None declared.

References
1 Zamboni S, Soria F, Mathieu R et al. Differences in trends in the use of robot-assisted and open radical cystectomy and changes over time in perioperative outcomes among selected centres in North America and Europe: an international multicentre collaboration. BJU Int 2019; 124: 656–64
2 Hussein AA, May PR, Jing Z et al. Outcomes of intracorporeal urinary diversion after robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. J Urol 2018; 199: 1302–11
3 Hosseini A, Adding C, Nilsson A, Jonsson MN, Wiklund NP. Robotic cystectomy: surgical technique. BJU Int 2011; 108: 962–8
4 Collins JW, Adding C, Hosseini A et al. Introducing an enhanced recovery programme to an established totally intracorporeal robot-assisted radical cystectomy service. Scand J Urol 2016; 50: 39–46
5 Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004; 240: 205–13
6 Hosseini A, Ebbing J, Collins J. Clinical outcomes of robot-assisted radical cystectomy and continent urinary diversion. Scand J Urol 2019; 53: 81–8
7 Sathianathen NJ, Kalapara A, Frydenberg M et al. Robotic assisted radical cystectomy vs open radical cystectomy: systematic review and meta-analysis. J Urol 2019; 201: 715–20
8 Parekh DJ, Reis IM, Castle EP et al. Robot-assisted radical cystectomy versus open radical cystectomy in patients with bladder cancer (RAZOR): an open-label, randomised, phase 3, non-inferiority trial. Lancet 2018; 391: 2525–36
9 Bochner BH, Dalbagni G, Sjoberg DD et al. Comparing open radical cystectomy and robot-assisted laparoscopic radical cystectomy: a randomized clinical trial. Eur Urol 2015; 67: 1042–50
10 Gandaglia G, Karl A, Novara G et al. Perioperative and oncologic outcomes of robot-assisted vs. open radical cystectomy in bladder cancer patients: a comparison of two high-volume referral centers. Eur J Surg Oncol 2016; 42: 1736–43
11 Bertolo R, Agudelo J, Garisto J, Armanyous S, Fergany A, Kaouk J. Perioperative outcomes and complications after robotic radical cystectomy with intracorporeal or extracorporeal ileal conduit urinary diversion: head-to-head comparison from a single-institutional prospective study. Urology 2019; 129: 98–105
12 Lenfant I, Verhoest G, Campi R et al. Perioperative outcomes and complications of intracorporeal vs extracorporeal urinary diversion after robot-assisted radical cystectomy for bladder cancer: a real-life, multi-institutional French study. World J Urol 2018; 36: 1711–8
13 Tan TW, Nair R, Saad S, Thurairajah R, Khan MS. Safe transition from extracorporeal to intracorporeal urinary diversion following robot-assisted cystectomy: a recipe for reducing operative time, blood loss and complication rates. World J Urol 2019; 37: 367–72
14 Tan WS, Lamb BW, Kelly JD. Evolution of the neobladder: a critical review of open and intracorporeal neobladder reconstruction techniques. Scand J Urol 2016; 50: 95–103
15 Chan KG, Collins JW, Wiklund NP. Robot-assisted radical cystectomy: extracorporeal vs intracorporeal urinary diversion. J Urol 2015; 193: 1467–9
16 Zhang JH, Ericson KJ, Thomas LJ et al. Large Single-institution comparison of perioperative outcomes and complications in open radical cystectomy, intracorporeal robot-assisted radical cystectomy, and robotic extracorporeal approach. J Urol 2020; 203: 512–21
17 Asimakopoulos AD, Campagna A, Gakis G et al. Nerve sparing, robot-assisted radical cystectomy with intracorporeal bladder substitution in the male. J Urol 2016; 196: 1549–57
18 Desai MM, Gill IS, de Castro Abreu AL et al. Robotic intracorporeal orthotopic neobladder during radical cystectomy in 132 patients. J Urol 2014; 192: 1734–40
19 Goh AC, Gill IS, Lee DJ et al. Robotic intracorporeal orthotopic ileal neobladder: replicating open surgical principles. Eur Urol 2012; 62: 891–901
20 Gok B, Atmaca AF, Canda AE et al. Robotic radical cystectomy with intracorporeal studer pouch formation for bladder cancer: experience in ninety-eight cases. J Endourol 2019; 33: 375–82
21 Koie T, Ohyama C, Makiyama K et al. Utility of robot-assisted radical cystectomy with intracorporeal urinary diversion for muscle-invasive bladder cancer. Int J Urol 2019; 26: 334–40
22 Koie T, Ohyama C, Yoneyama T et al. Robotic cross-folded U-configuration intracorporeal ileal neobladder for muscle-invasive bladder cancer: Initial experience and functional outcomes. Int J Med Robot 2018; 14: e1955
23 Simone G, Papalia R, Misuraca L et al. Robotic intracorporeal padua ileal bladder: surgical technique, perioperative, oncologic and functional outcomes. Eur Urol 2018; 73: 934–40
24 Simone G, Tuderti G, Misuraca L et al. Perioperative and mid-term oncologic outcomes of robotic assisted radical cystectomy with totally intracorporeal neobladder: results of a propensity score matched comparison with open cohort from a single-centre series. Eur J Surg Oncol 2018; 44: 1432–8
25 Tan WS, Lamb BW, Tan MY et al. In-depth critical analysis of complications following robot-assisted radical cystectomy with intracorporeal urinary diversion. Eur Urol Focus 2017; 3: 273–9
Intracorporeal neobladder urinary diversion

© 2020 The Authors
BJU International published by John Wiley & Sons Ltd on behalf of BJU International

26 Tan WS, Sridhar A, Goldstraw M et al. Robot-assisted intracorporeal pyramid neobladder. BJU Int 2015; 116: 771–9
27 Tyritzis SI, Hosseini A, Collins J et al. Oncologic, functional, and complications outcomes of robot-assisted radical cystectomy with totally intracorporeal neobladder diversion. Eur Urol 2013; 64: 734–41
28 Schwentner C, Sim A, Balbay MD et al. Robot-assisted radical cystectomy and intracorporeal neobladder formation: on the way to a standardized procedure. World J Surg Oncol 2015; 13: 3
29 Hautmann RE, de Petronici RC, Volkmer BG. Lessons learned from 1,000 neobladders: the 90-day complication rate. J Urol 2010; 184: 990–4; quiz 1235.
30 Collins JW, Patel H, Adding C et al. enhanced recovery after robot-assisted radical cystectomy: EAU robotic urology section scientific working group consensus view. Eur Urol 2016; 70: 649–60
31 Novotny V, Hakenberg OW, Wiessner D et al. Perioperative complications of radical cystectomy in a contemporary series. Eur Urol 2007; 51: 397–401
32 Nieuwenhuijzen JA, de Vries RR, Bex A et al. Urinary diversions after cystectomy: the association of clinical factors, complications and functional results of four different diversions. Eur Urol 2008; 53: 834–42
33 Nguyen DP, Al Hussein Al Awamlh B, Wu X et al. Recurrence patterns after open and robot-assisted radical cystectomy for bladder cancer. Eur Urol 2015; 68: 399–405
34 Yuh B, Wilson T, Bochner B et al. Systematic review and cumulative analysis of oncologic and functional outcomes after robot-assisted radical cystectomy. World J Surg 2015; 39: 402–22
35 Raza SJ, Wilson T, Peabody JO et al. Long-term oncologic outcomes following robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. Eur Urol 2015; 68: 721–8
36 Gschwend JE, Heck MM, Lehmann J et al. Extended versus limited lymph node dissection in bladder cancer patients undergoing radical cystectomy: survival results from a prospective, randomized trial. Eur Urol 2019; 75: 604–11
37 Stein JP, Lieskovsky G, Cote R et al. Radical cystectomy in the treatment of invasive bladder cancer: long-term results in 1,054 patients. J Clin Oncol. 2001; 19: 666–75
38 Hussein AA, Elsayed AS, Aldhaam NA et al. Comparison of long-term oncologic outcomes among historical open and minimally invasive retrospective studies. J Urol 2019; 269: 887–94
39 Collins JW, Wiklund NP. Totally intracorporeal robot-assisted radical cystectomy: optimizing total outcomes. BJU Int 2014; 114: 326–33
40 Prideon S, Bishop CV, Adshead J. Lower limb compartment syndrome as a complication of robot-assisted radical prostatectomy: the UK experience. BJU Int 2013; 112: 485–8
41 Quddus A, Lawlor M, Siddiqui A, Holmes P, Plant GT. Using diffusion-weighted magnetic resonance imaging to confirm a diagnosis of posterior ischaemic optic neuropathy: two case reports and literature review. Neuroophthalmology 2015; 39: 161–5
42 Stevens WR, Glazer PA, Kelley SD, Lietman TM, Bradford DS. Ophthalmic complications after spinal surgery. Spine 1997; 22: 1319–24
43 Williams EL, Hart WM Jr, Tempelhoff R. Postoperative ischemic optic neuropathy. Anesth Analg 1995; 80: 1018–29

Correspondence: Abolfazl Hosseini, Karolinska University Hospital, 171 76 Stockholm, Sweden.
e-mail: Abolfazl.Hosseini@ki.se

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CSS, cancer-specific survival; EBL, estimated blood loss; ERP, enhanced recovery protocol; OS, overall survival; PION, posterior infarction of optic nerve; PLND, pelvic lymph node dissection; PSM, positive surgical margin; (O)(RA)RC, (open) (robot-assisted laparoscopic) radical cystectomy; RFS, recurrence-free survival; (EC)(IC) UD, (extra corporeal) (intracorporeal) urinary diversion.

Supporting Information
Additional Supporting Information may be found in the online version of this article:
Table S1. List of components of our enhanced recovery programme (ERP) for robot-assisted radical cystectomy (RARC).