



## Surgery in Motion

# Robot-Assisted Radical Cystectomy with Intracorporeal Urinary Diversion in Patients with Transitional Cell Carcinoma of the Bladder

Martin N. Jonsson\*, L. Christofer Adding, Abolfazl Hosseini, Martin C. Schumacher, Daniela Volz, Andreas Nilsson, Stefan Carlsson, N. Peter Wiklund

Department of Molecular Medicine and Surgery, Section of Urology, Karolinska Institutet, Stockholm, Sweden

### Article info

#### Article history:

Accepted July 8, 2011

Published online ahead of print on August 4, 2011

#### Keywords:

Robotic surgery  
Radical cystectomy  
Bladder cancer  
Transitional cell carcinoma

#### Please visit

[www.europeanurology.com](http://www.europeanurology.com) and  
[www.urosources.com](http://www.urosources.com) to view the  
accompanying video.

### Abstract

**Background:** Robot-assisted radical cystectomy (RARC) may reduce morbidity after cystectomy. Descriptions of the surgical techniques of RARC with intracorporeal orthotopic neobladder or ileal conduit are sparse and oncologic and functional outcome data have not been reported.

**Objective:** We present our technique with RARC and intracorporeal urinary diversion (neobladder or ileal conduit) and present oncologic and functional outcomes, as well as complication rates.

**Design, setting, and participants:** Single-hospital institution case-series from 2004 to 2009 including 45 selected patients (38 male, 7 female) with high-grade and/or muscle-invasive urothelial cancer of the bladder.

**Surgical procedure:** We performed RARC; pelvic lymph node dissection using three different templates; and a totally intracorporeal urinary diversion, either orthotopic neobladder ( $n = 36$ ) or ileal conduit ( $n = 9$ ).

**Measurements:** Perioperative variables, pathology data, early and late complication rates, urinary continence, potency, and cancer-specific survival were evaluated as outcome measures.

**Results and limitations:** Median patient age, operative time, estimated blood loss, and lymph node yield were 62 yr (range: 37–79), 477 min (range: 325–760), 550 ml (range: 200–2200), and 19 (range: 10–52), respectively. Nine patients were diagnosed with positive lymph nodes. Surgical margins were clear in all but one patient. Early complications occurred in 18 patients (40%). Median postoperative stay was 9 d (range: 4–78), and median postoperative follow-up time was 25 mo. Four patients died due to metastatic disease.

The study is limited by a relative small sample size and no comparative group.

**Conclusions:** RARC with totally intracorporeal urinary diversion is technically feasible with good intermediate-term oncologic results. This is a nonrandomised study including a limited number of patients with a restricted follow-up time, however, and so precautions must be considered when interpreting the outcomes.

© 2011 European Association of Urology. Published by Elsevier B.V. All rights reserved.

\* Corresponding author. Department of Urology, Karolinska University Hospital, Solna, SE-171 76 Stockholm, Sweden. Tel. +46 8 51774633; Fax: +46 8 51773599.

E-mail address: [martin.n.jonsson@karolinska.se](mailto:martin.n.jonsson@karolinska.se) (M.N. Jonsson).

## 1. Introduction

Open radical cystectomy (ORC) with pelvic lymphadenectomy and urinary diversion is still considered the

gold-standard treatment in patients with invasive bladder cancer [1]. Even though morbidity and mortality of ORC have significantly improved over time and good functional results have been achieved in patients with orthotopic

urinary diversions, ORC is a surgical procedure associated with significant early and late complication rates, even at centres of excellence [2,3].

Minimal invasive surgery has been introduced to reduce morbidity and decrease hospital stay. Laparoscopic radical cystectomy was first described in 1992, but technical difficulties have prevented a widespread adoption of this approach [4]. With the introduction of robot-assisted laparoscopic surgery with three-dimensional vision, a 10-fold magnification, and dexterity provided by the endowrist instrumentation, robot-assisted radical cystectomy (RARC) has emerged as an alternative to the open procedure. Most RARC surgeons advocate a combination of robot-assisted laparoscopy and open surgery, performing the cystectomy and lymphadenectomy with the robot, and, due to longer operative time [5–9], using an extracorporeal approach for the construction of the conduit or neobladder [5]. However, some centres, including our own institution, have developed techniques for RARC with a complete intracorporeal urinary diversion [10,11].

The objective of this report is to describe the surgical technique for RARC and total intracorporeal urinary diversion, and to present the surgical complications as well as oncologic and functional outcomes.

## 2. Patients and methods

From 2004 to 2009, approximately 300 cystectomies were performed at the Karolinska University Hospital. During the same period, a surgeon experienced in ORC and robot-assisted radical prostatectomy performed 45 RARC including intracorporeal urinary reconstruction (7 women) and 40 ORC for patients with clinically high-risk or muscle-invasive bladder cancer. Exclusion criteria for RARC were patients with a history of extensive abdominal surgery, severe cardiopulmonary disease, and bulky tumours; age >75 yr and body mass index (BMI) >30 were relative contraindications. The patients had a choice between RARC and open procedure if no exclusion criteria existed. We used the standard da Vinci robotic system (Intuitive Surgical, Sunnyvale, CA, USA) for the first 20 patients and the da Vinci Si system for the remaining 25 patients. By patient choice, an orthotopic ileal neobladder or an ileal conduit was created intracorporeally. The technique was slightly changed over the first 4 yr. The procedure described in this paper emerged from the technique used since 2008. One patient underwent neoadjuvant chemotherapy. No patient received preoperative radiotherapy. All patients received preoperative intravenous broad-spectrum antibiotics (cefotaxim and metronidazole) and low-molecular-weight heparin (4000 units).

Perioperative parameters and postoperative complications, reported according to the Clavien classification [12–14], were prospectively recorded in a database. Postoperatively, patients were followed at 6 wk; at 3, 6, 12, 18, and 24 mo; and thereafter once a year. Postoperative functional outcome regarding continence and potency rates were assessed. The International Index of Erectile Function (IIEF)-5 score was used for regional patients, that is, those living in the Stockholm area. For patients from other areas of Sweden, a nurse interviewed the patients regarding erectile function. A patient was defined potent if IIEF-5 score was  $\geq 17$  or if he could perform intercourse on more than half of the times attempted, with or without a phosphodiesterase (PDE) inhibitor. A nurse interviewed the patients regarding urinary continence. Continence was defined as the usage of zero to one safety pad. Incontinence was defined as the use of one wet pad or more.

### 2.1. Surgical technique

#### 2.1.1. Port placement and patient preparation

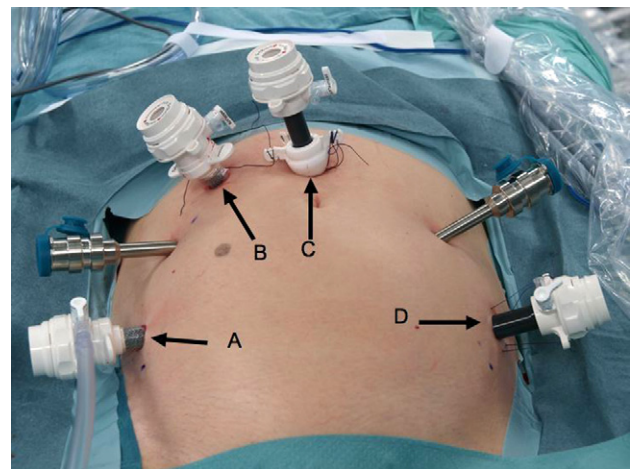
A six-port transperitoneal approach was used according to the Hasson technique [15,16]. The 12-mm camera port was placed supraumbilically. Two 8-mm robotic ports were placed lateral to the umbilicus: one 10 cm to the right and the other 8 cm to the left. A third 8-mm robotic port was placed inside a 15-mm port in the left fossa. This made it possible to alternate the use of this port (eg, to staple the intestine or to use the fourth robotic arm). Two 12-mm assistant ports were placed, one just above the right anterior superior iliac spine and the other midway between the right robotic port and the camera port (Fig. 1). A 0° camera lens was used throughout the procedure. Pneumoperitoneum was 8–12 mm Hg and the patient was placed in the Trendelenburg position (20–25°). During urinary reconstruction, the tilting was reduced to 10–15°. The console surgeon used a Maryland bipolar cautery forceps in the left arm and a monopolar pair of scissors in the right arm. A pair of Cadere forceps (Intuitive Surgical, Sunnyvale, CA, USA) was used for handling the intestine.

#### 2.1.2. Identification and dissection of the ureters

The ureter was identified at the crossing of the common iliac artery, carefully dissected to the ureterovesical junction, clipped using Hem-o-lok clips (Weck Closure Systems, Research Triangle Park, NC, USA), and divided. Adequate periureteric tissue was preserved to maintain generous vascular supply. A stay suture was used at the distal end of the left ureter to facilitate its mobilisation below the sigmoid colon.

#### 2.1.3. Male radical cystectomy

A 7- to 8-cm transverse peritoneal incision in the pouch of Douglas at the seminal vesicles was made identically to that previously described for robot-assisted radical prostatectomy [17]. The umbilical ligaments and the urachus were divided proximally, allowing entry into the space of Retzius to mobilise the bladder. The lateral pedicles were divided by the assistant using Ligasure (Valleylab, Boulder, CO, USA). In case of attempted nerve-sparing procedure, an intrafascial dissection was performed at the dorsolateral part of the prostate. Hem-o-lok clips were used to avoid thermal injury to the neurovascular bundles due to cautery. The dorsal venous complex was transected and controlled using a 2-0 suture (Biosyn CV-25 needle; Covidien Corp., Dublin, Ireland) [17].



**Fig. 1 – Trocar placement.** The assistant uses (A) one 12-mm trocar placed 10 cm lateral to the umbilicus; (B) one 12-mm trocar between the right robotic trocar and (C) the camera trocar, respectively; and (D) one 15-mm trocar for the EndoCatch (Covidien Corp., Dublin, Ireland), the stapling device, and as an entrance for the robotic fourth arm.

#### 2.1.4. Female radical cystectomy

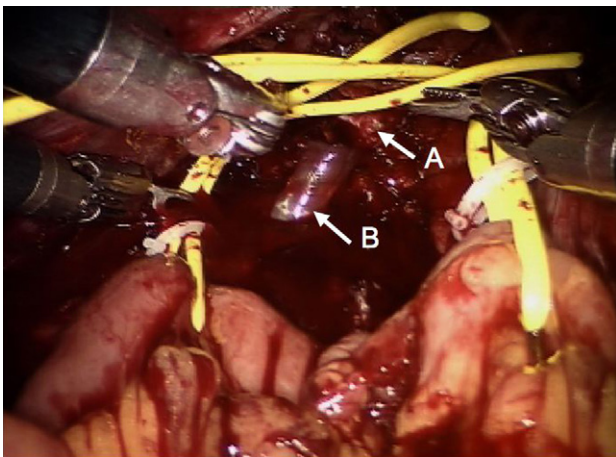
An inverted U incision in the cul-de-sac was performed as described above. After transecting the round ligament, the vascular pedicles were divided using Ligasure. For patients receiving an ileal conduit diversion, the bladder was removed en bloc with the anterior vaginal wall via the introitus and the vagina was closed using the *clam-shell technique* with a running suture [18]. For patients with orthotopic neobladder, the vagina was dissected free from the bladder and the urethra transected at the level of the bladder neck. To preserve sexual function, the endopelvic fascia remained intact to avoid harm to the autonomic nerves lateral to the vagina.

#### 2.1.5. Pelvic lymph node dissection and tunneling of the left ureter

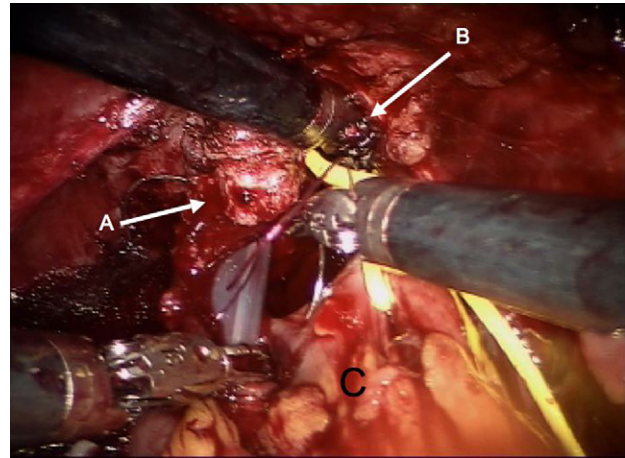
We used three different templates when performing pelvic lymph node dissection (PLND). With the da Vinci Si robotic system we could reach the aortic bifurcation, unlike the standard system, in which we had to stop at the common iliac artery. Clinical stage and grade also affected the choice of template. Fourteen patients received a PLND up to the aortic bifurcation, including lymphatic tissues from the triangle of Marcille, along the internal iliac vessels, and from the presacral area. The node of Cloquet and the genitofemoral nerve constituted the distal and lateral borders, respectively. Twenty-two patients received a PLND up to the point where the ureter crosses the common iliac artery, including the triangle of Marcille, and five patients with low-stage tumour received a PLND distal to the hypogastric artery. If a nerve-sparing procedure was performed, a meticulous dissection without cautery was done to avoid damage to the autonomic nerves in the area lateral to the seminal vesicles and along the perirectal fascia. Following PLND, the left ureter was tunnelled under the sigmoid mesentery to the right side by gently lifting the colon with Cadieere forceps.

#### 2.1.6. Intracorporeal continent urinary tract reconstruction (orthotopic neobladder)

The ileal segment was pulled down to the urethra by two Ligalooop (Braun-Dexon, Spangenberg, Germany) strings positioned through the mesenteric border around the intestine adjacent to the site of the anastomosis (Fig. 2). A 20-Ch opening was made in the antimesenteric site of the ileum. The anastomosis was performed according to the Van Velthoven technique with a 2 × 18-cm 2-0 Biosyn suture [19] (Fig. 3). The intestine was then isolated using a laparoscopic 60-mm intestinal stapler (Endo-GIA; Covidien Corp., Dublin, Ireland) inserted by the assistant using the 15-mm port on the left side. The ileum was stapled 40 cm proximal and 10 cm distal to the enterourethral anastomosis. The continuity of the small bowel was restored by stapling the ileal ends (antimesenteric) side to side



**Fig. 2** – Preparing the anastomosis between (A) urethra and the substitute using two vessel loops on each side of the anastomosis; (B) a catheter in the urethra facilitates the suturing procedure.

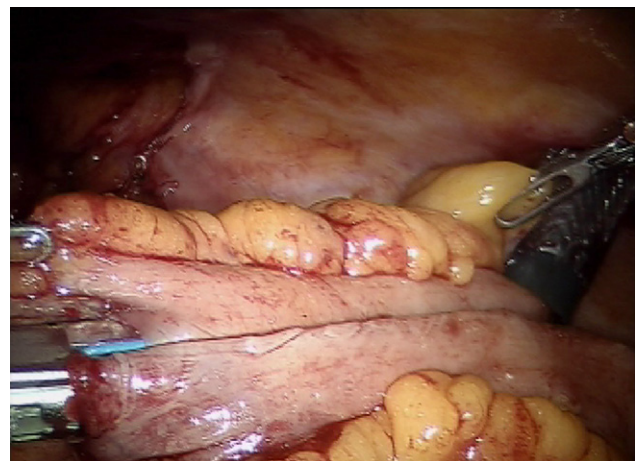


**Fig. 3** – The anastomosis between (A) the urethra and (C) the substitute. The fourth arm holds (B) the right vessel loop in a fixed position to reduce the traction between the urethra and the substitute when suturing the anastomosis.

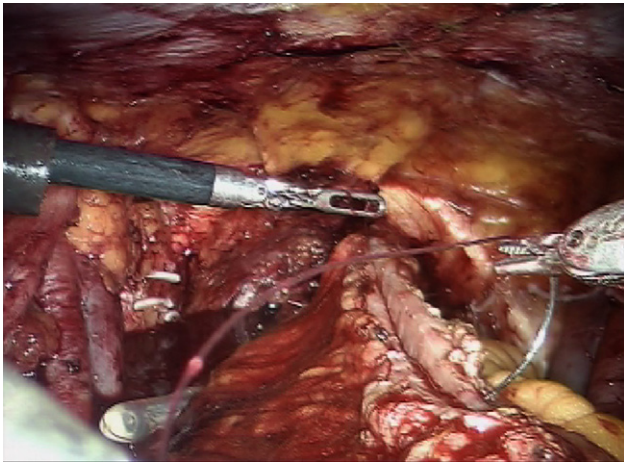
using the 60-mm Endo-GIA (Fig. 4). A transverse 60-mm stapling of the Endo-GIA was used to close the open ends of the ileal limbs.

**2.1.6.1. Formation of the neobladder.** The distal 40 cm of the isolated ileal segment was detubularised, leaving a 10-cm, intact, proximal isoperistaltic afferent limb. The posterior part of the Studer reservoir was closed using multiple running sutures (25-cm 3-0 Biosyn) in a seromuscular fashion (Fig. 5) [20]. The incipient neobladder was then folded by connecting the right proximal (upper) part to the left distal (lower) part of the neobladder and the distal half of the reservoir was then completed by suturing the distal anterior wall. The proximal half of the reservoir was left open until it was closed during the last part of the procedure.

**2.1.6.2. Uretero-enteral anastomosis and closure of the Studer reservoir.** The anastomosis between the ureters and the afferent limb was performed using the Wallace technique; the same technique was used for ORC. The ureters were spatulated 2–3 cm and the posterior walls were sutured side to side using a 15-cm running 4-0 Biosyn (Fig. 6). Two single-J 40-cm ureteric stents were inserted via the Seldinger



**Fig. 4** – Side-to-side anastomosis of the ileum using Endo-GIA 60 mm (Covidien Corp., Dublin, Ireland).



**Fig. 5** – Seromuscular suturing technique is used when constructing the substitute: the posterior wall. Stay sutures facilitate the procedure.

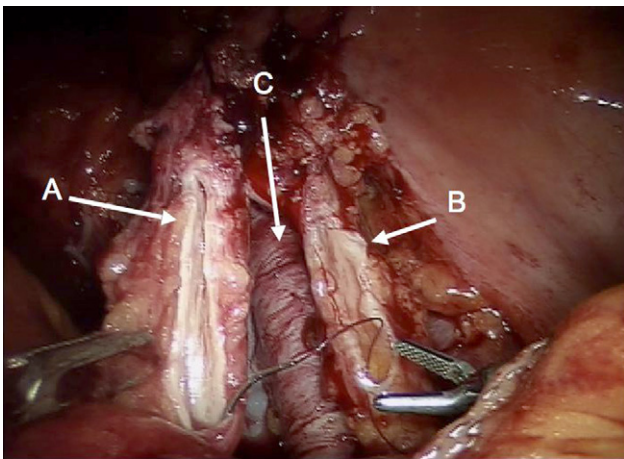
technique through the abdominal wall in the midline just above the symphysis [21]. The stents were pulled through the afferent limb by using a Cardiere forceps and pushed up into the ureters on each side (Fig. 7). The Wallace plate was attached to the afferent limb of the Studer pouch using a 2 × 18-cm 4-0 Biosyn suture. The remaining part of the reservoir was closed and the catheter balloon was filled with 10 ml of fluid. The neobladder was then filled with 50 ml of saline to check for leakage; if there was leakage, extra sutures were considered. A 21-Ch passive drainage was placed through one of the ports.

#### 2.1.7. Intracorporeal noncontinent urinary tract reconstruction (ileal conduit)

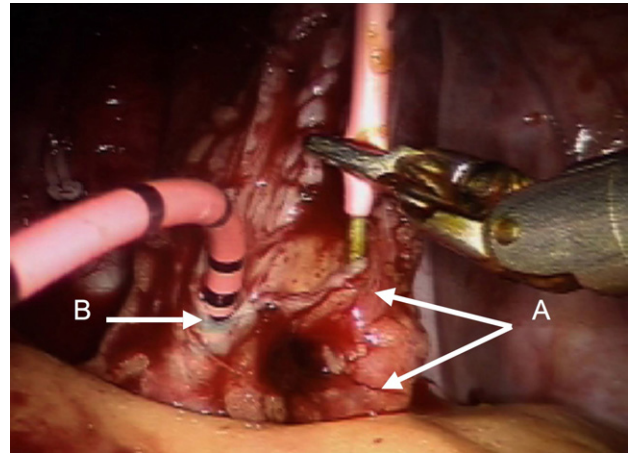
In patients receiving ileal conduit, 20 cm of intestine were isolated from the terminal ileum. The ureteroenteral anastomosis, including the placement of the stents through the ileal conduit, was constructed as described above. The abdominal wall was incised and the distal end of the conduit was fashioned as an urostoma.

#### 2.1.8. Postoperative management

Manual irrigation of the bladder substitute was done intermittently every 8 h. The drain tube was removed when the amount of fluid was



**Fig. 6** – Suture of (A) left and (B) right ureter side to side, according to the Wallace technique. The right common iliac artery is seen dorsal to the (C) ureters.



**Fig. 7** – Placement of the right stent into the (A) right ureter. The left stent is already in place in the (B) left ureter.

<200 ml. The ureteral stents were removed 7 d postoperatively. The urethral catheter was removed 3–4 wk after the operation. Pain control was achieved with oxycodon 10 mg twice a day, paracetamol 1 g four times a day, and intravenous or subcutaneous morphine when needed.

#### 2.2. Statistical analysis

Descriptive statistics are shown in the cross-tables, with medians and range given for continuous data and proportions for categorical data. Differences between groups in continuous and ordinal outcomes were evaluated using the Wilcoxon-Mann-Whitney test, and differences in categorical outcomes were tested using Fisher's exact test. Cancer-specific survival was assessed using the Kaplan-Meier estimator from which 36-mo cancer-specific survival was calculated; the log-log transformation was used to get a 95% confidence interval (CI). All tests were performed at the 5% significance level. The data analysis was performed using SPSS v.19 (IBM Corp., Somers, NY, USA).

### 3. Results

An orthotopic ileal neobladder was constructed in 36 patients (3 women) with an attempt at nerve-sparing surgery in 20 male patients. An ileal conduit was created in nine patients (four women); one male had a nerve-sparing procedure. Median age, BMI, operative time, perioperative blood loss, and hospital stay are described in Table 1. The median overall number of lymph nodes removed was 19 (range: 10–52). In 14 patients, a PLND was performed up to the aortic bifurcation with a median of 31 nodes removed (range: 19–52). Surgical margins of the cystectomy specimens were negative in all but one patient (focal positive margin lateral to the right ureter, pT3a N2), who is still alive without recurrence 38 mo after surgery. Pathologic results and postoperative follow-up times are presented in Table 2.

#### 3.1. Complications and reason for conversion to open surgery

Early surgery-related complications ( $\leq 30$  d) occurred in 40% of the patients. Reoperation was necessary in two patients because of arterial bleeding and small bowel

**Table 1 – Patient characteristics and perioperative data for patients undergoing robot-assisted radical cystectomy and intracorporeal urinary diversion**

	All patients, N = 45, median (range)	Patients with neobladder, n = 36, median (range)	Patients with conduit, n = 9, median (range)	p value
<b>Patient characteristics</b>				
Age, yr	62 (37–79)	60 (37–73)	73 (55–79)	0.001
Gender ratio (M:F)	38:7	33:3	5:4	0.022
BMI	26 (18–33)	26 (18–33)	24 (21–26)	0.135
<b>Perioperative data</b>				
EBL, ml	550 (200–2200)	625 (200–2200)	350 (200–2000)	0.147
OP time, min	477 (325–760)	480 (330–760)	460 (325–561)	0.455
LOS, d	9 (4–78)	9 (4–78)	17 (6–72)	0.013
BMI = body mass index; EBL = estimated blood loss; OP = operative time; LOS = length of hospital stay.				

anastomosis insufficiency. One of the patients received a femoral-femoral bypass, but died 3 mo after RARC due to acute bleeding from an aortojejunal fistula. Late surgery-related complications (>30 d) were observed in one third of the cases (Table 3). Two patients required conversion to open surgery mainly because of technical problems, long operative times related to the construction of the reservoir, and anastomotic insufficiency between the urethra and the reservoir. There was no statistical difference in complication rates between neobladder- and conduit-operated patients. Twenty patients had no complications (44%).

### 3.2. Oncologic outcome

Follow-up time was  $\geq 16$  mo in all but two patients, who died after 3 and 13 mo, respectively. Median postoperative

follow-up time was 25 mo (range: 3–90 mo) and overall patient recurrence-free survival was 84% (Table 2). Cancer-specific survival (Kaplan-Meier survival estimates) is plotted in Figure 8. Four patients died due to metastasis after 13, 14, 22, and 36 mo, respectively. Calculated 3-yr cancer-specific survival probability was 86%, (95% CI, 65–95%). Histopathology showed a pT4a plus carcinoma in situ (CIS), a T2b plus CIS with six positive lymph nodes, a high-grade pT3b, and a high-grade pT2b with 30 positive lymph nodes, respectively, in these four patients. Two patients were diagnosed with cancer recurrence. One male patient with pT1G3 TCC was diagnosed with urethral CIS 14 mo after surgery, despite initial negative frozen section of the urethra. Due to the presence of persistent malignant urothelial cells after urethral bacillus Calmette-Guérin instillation, a urethrectomy was performed and an ileal conduit created 29 mo after RARC. The other

**Table 2 – Follow-up time, clinical stage, lymph node yield, pathologic stage, and recurrence-free survival in patients undergoing robot-assisted radical cystectomy with intracorporeal urinary diversion**

	Overall		Neobladder		Conduit	
	N	RFS	n	RFS	n	RFS
All patients (%)	45 (100)	84	36 (100)	89	9 (100)	67
Follow-up, mo, median (range)	25 (3–90)	27 (16–90)	24 (13–90)	24 (16–90)	32 (3–88)	50 (16–88)
<b>Clinical stage (%)</b>						
TaTis	3 (7)	95	2 (5)	100	1 (11)	0
T1	17 (38)	88	14 (39)	86	3 (33)	100
T2	22 (49)	81	19 (53)	89	3 (33)	33
T3	3 (7)	100	1 (3)	100	2 (23)	100
Lymph node yield, median (range)	19 (10–52)		19 (10–52)		27 (11–42)	
<b>Pathologic stage</b>						
Lymph node negative	n (%)	%	n (%)	%	n (%)	%
pT0pTapTis	36 (80)	94	30 (83)	93	6 (67)	100
pT1	13 (29)	97	11 (30)	96	2 (22%)	100
pT2	8 (18)		6 (17)		2 (22)	
pT3	8 (18)		7 (19)		1 (11)	
pT4	5 (11)		5 (14)			
Lymph node positive	9 (20)	57	1 (3)	67	1 (11)	0
pT0pTapTis	1 (2)	56	6 (17)	67	3 (33)	33
pT1	0 (0)	50	1 (3)	60	0 (0)	0
pT2	0 (0)		0 (0)			
pT3	5 (11)		4 (11)			
pT4	3 (7)		1 (3)			
	0 (0)	67	0 (0)	100	0 (0)	50

RFS = recurrence-free survival.

**Table 3 – Early ( $\leq 30$  d) and late ( $>30$  d) surgical complications according to Clavien [13] in robot-assisted radical cystectomy with intracorporeal urinary diversion**

	Overall, n = 45		Neobladder, n = 36		Conduit, n = 9	
	Early	Late	Early	Late	Early	Late
Clavien grade						
Grade 1	6	6	5	5	1	1
Grade 2	2	1	2	1	0	0
Grade 3a	5	1	4	1	1	0
Grade 3b	4	7	3	5	1	2
Grade 4a	1	0	0	0	1	0
Grade 4b	0	0	0	0	0	0
Grade 5	0	0	0	0	0	0
Total, %	40	33	39	33	44	33

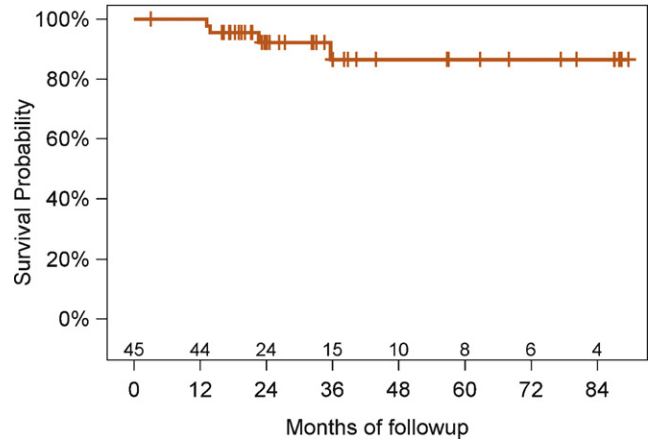
patient, a woman with lymph node positive disease at surgery, was diagnosed with gross lymph nodes on computed tomography 4 mo after cystectomy. She was successfully treated with radiochemotherapy 17 mo ago as of this writing and is still in remission.

**3.3. Functional outcome**

Continence and potency data in patients with orthotopic neobladder were assessed at 12 mo (Table 4). Patients with neobladder had daytime and nocturnal continence rates of 97% and 83%, respectively. In 20 male patients, bilateral nerve-sparing surgery was done. Potency outcome was reported by 16 patients and only one patient was impotent (Table 4). IIEF-5 score was reported by eight of 11 regional patients (mean score: 19 [standard deviation: 2.9]).

**3.4. Learning curve**

Comparing the patient data of the first 18 with the last 18 RARC performed with intracorporeal neobladder in our series shows a reduced median operative time of 517 min (range: 360–760 min) and 417 min (range: 330–588 min) ( $p = 0.001$ ); increased blood loss of 575 ml (range: 200–2200 ml) and 670 ml (range: 250–1400 ml) ( $p = 0.769$ ); and shorter hospital stay 10 d (range: 4–78 d) and 8 d (range: 4–28 d) ( $p = 0.134$ ), respectively. Early and late complications decreased from 50% (nine of 18 patients) to 28% (five of 18)



**Fig. 8 – Cancer-specific survival. Kaplan-Meier survival estimate with number of at-risk subjects is on the x-axis. Forty-five patients were treated with robot-assisted radical cystectomy and intracorporeal urinary diversion.**

( $p = 0.305$ ) and from 50% (nine of 18) to 17% (three of 18) ( $p = 0.075$ ), respectively (Table 5).

**4. Discussion**

Despite the high degree of complex surgical steps, the procedure is technically feasible and reproducible with promising results regarding oncologic and functional outcomes. The rate of complications decreased significantly over time, which can be attributed to the standardisation of our technique and the learning curve. Long-term complication rates are not inferior to findings in ORC series [2,3]. It has been suggested that RARC is associated with less morbidity compared to open procedures; however, RARC with totally intracorporeal urinary diversion is considered a challenge [8,10,11].

Comparing the first with the second half of our orthotopic neobladder patients, mean operative time decreased by 100 min even though more patients underwent a more extensive PLND. Operative time in our series, however, remains longer compared to open series. Median estimated blood loss (550 ml) is comparable to a recent randomised trial comparing robotic and open cystectomy [22]. We observed an increase in blood loss in the latter

**Table 4 – Urinary incontinence and potency outcome at 12-mo follow-up in robot-assisted radical cystectomy with intracorporeal neobladder reconstruction (n = 36 patients, 33 male)**

Nerve-sparing surgery performed, n	Patients with urinary incontinence, n						Patients reporting potency, n		
	0–1 pad		$\geq 1$ wet pads		MD		Yes	No	MD
	Day	Night	Day	Night	Day	Night			
Yes, 20	17	15	0	2	3	3	15	1	4
No, 16	13	9	1	3	2	4	NA	NA	NA

MD = missing data; NA = not applicable.

**Table 5 – Patient characteristics, perioperative data, and surgical complications (first 18 patients compared with the last 18 patients in robot-assisted radical cystectomy with intracorporeal orthotopic neobladder operation)**

	Neobladder 1–18, median (range)	Neobladder 19–36, median (range)	All 36 neobladders, median (range)
<b>Patient characteristics</b>			
Age	58 (37–71)	60 (42–73)	60 (37–73)
Gender ratio (male:female)	15:3	18:0	33:3
BMI	26 (18–27)	26 (18–33)	26 (18–33)
<b>Perioperative data</b>			
EBL, ml	575 (200–2200)	670 (250–1400)	625 (200–2200)
OP time, min	517 (360–760)	417 (330–588)	480 (330–760)
LOS, d	10 (4–78)	8 (4–28)	9 (4–78)
Early complications, %	50	28	39
Late complications, %	50	17	33

BMI = body mass index; EBL = estimated blood loss; OP = operative time; LOS = length of stay.

half of our series, mainly as more patients were treated with an extended PLND and an orthotopic bladder reconstruction.

Long operative times of RARC with totally intracorporeal urinary diversion have prevented widespread adoption of this approach and most centres prefer an extracorporeal approach for urinary diversion [5–7,9]. We believe there are some advantages to performing the urinary diversion intracorporeally. First, the anastomosis between the urethra and the ileum can be done using a running suture according to the Van Velthoven technique, thus minimising the risk for urinary leakage. There is less traction to the anastomosis between the reservoir and the urethra using intracorporeal technique, as an appropriate ileal segment long enough to reach down to the urethra is used. Second, only a 4-cm skin incision at the end of the procedure is needed to extract the specimen (in women, extraction through the vagina is feasible). This provides not only good cosmetics, but might also allow a faster return to normal activity. Third, the ureters may be cut shorter to reduce the risk of stricture due to ischemia in the distal end of the ureter. However, after a standardisation of the procedure step by step, access to a training program should facilitate a widespread adoption of this technique.

Median postoperative follow-up time was 25 mo and during this period we observed a cancer-specific survival rate of approximately 84%. Surgical margins were negative in all but one patient (pT3a N2) in a series in which 22% of patients had non-organ-confined disease. Our lymph node yield with the robot is similar to data from open series [23–25].

The depth perception and optical magnification using the robot system may positively influence functional results at RARC. All but one patient had intercourse with or without PDE inhibitors at 3 mo. Further, it facilitates suturing the anastomosis between the urethra and the reservoir, which may improve urinary continence. In our series, good daytime and acceptable nocturnal continence rates were seen 12 mo after RARC (Table 4). However, the fact that only regional patients were assessed by IIEF-5 score and no other quality-of-life instrument was used can cause an observer bias and that is a limitation of this study.

Today, >1000 RARC cases are reported and series demonstrate oncologic outcomes comparable to those of open series [26–28]. Our results are also in agreement with oncologic outcome similar to open surgery. However, in our series, patients were carefully selected and therefore a bias towards less comorbidity and better performance status will be reflected in surgical outcome. Randomised controlled trials are warranted to quantify possible advantages of RARC compared to ORC.

## 5. Conclusions

RARC with totally intracorporeal urinary diversion is technically feasible with acceptable morbidity. Robotic-assisted laparoscopic extended PLND removed a median of 32 nodes. The oncologic outcome is promising. One year after RARC, excellent daytime continence and potency rates were reported.

**Author contributions:** Martin Jonsson had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Study concept and design:** Jonsson, Wiklund, Adding.

**Acquisition of data:** Jonsson, Adding, Hosseini, Schumacher.

**Analysis and interpretation of data:** Jonsson, Wiklund.

**Drafting of the manuscript:** Jonsson, Adding.

**Critical revision of the manuscript for important intellectual content:** Nilsson, Carlsson.

**Statistical analysis:** Adding, Hosseini.

**Obtaining funding:** None.

**Administrative, technical, or material support:** Volz.

**Supervision:** Wiklund.

**Other (specify):** None.

**Financial disclosures:** I certify that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (eg, employment/affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following: None.

**Funding/Support and role of the sponsor:** Financial support was provided through the regional agreement on medical training and clinical research (ALF) between Stockholm County Council and Karolinska Institutet.

**Acknowledgment statement:** We thank Tommy Nyberg for providing us statistics and generating the Kaplan-Meier plot.

## Appendix A. Supplementary data

The Surgery in Motion video accompanying this article can be found in the online version at [doi:10.1016/j.eururo.2011.07.035](https://doi.org/10.1016/j.eururo.2011.07.035) and via [www.europeanurology.com](http://www.europeanurology.com).

## References

- [1] Stein JP. Improving outcomes with radical cystectomy for high-grade invasive bladder cancer. *World J Urol* 2006;24:509–16.
- [2] 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.
- [3] Hautmann RE, Volkmer BG, Schumacher MC, Gschwend JE, Studer UE. Long-term results of standard procedures in urology: the ileal neobladder. *World J Urol* 2006;24:305–14.
- [4] Parra RO, Andrus CH, Jones JP, Boullier JA. Laparoscopic cystectomy: initial report on a new treatment for the retained bladder. *J Urol* 1992;148:1140–4.
- [5] Murphy DG, Challacombe BJ, Elhage O, et al. Robotic-assisted laparoscopic radical cystectomy with extracorporeal urinary diversion: initial experience. *Eur Urol* 2008;54:570–80.
- [6] Wang GJ, Barocas DA, Raman JD, Scherr DS. Robotic vs open radical cystectomy: prospective comparison of perioperative outcomes and pathological measures of early oncological efficacy. *BJU Int* 2008;101:89–93.
- [7] Pruthi RS, Wallen EM. Robotic assisted laparoscopic radical cystoprostatectomy: operative and pathological outcomes. *J Urol* 2007;178:814–8.
- [8] Keim JL, Theodorescu D. Robot-assisted radical cystectomy in the management of bladder cancer. *ScientificWorldJournal* 2006;6:2560–5.
- [9] Guru KA, Kim HL, Piacente PM, Mohler JL. Robot-assisted radical cystectomy and pelvic lymph node dissection: initial experience at Roswell Park Cancer Institute. *Urology* 2007;69:469–74.
- [10] Sala LG, Matsunaga GS, Corica FA, Ornstein DK. Robot-assisted laparoscopic radical cystoprostatectomy and totally intracorporeal ileal neobladder. *J Endourol* 2006;20:233–5, discussion 236.
- [11] Beecken W-D, Wolfram M, Engl T, et al. Robotic-assisted laparoscopic radical cystectomy and intra-abdominal formation of an orthotopic ileal neobladder. *Eur Urol* 2003;44:337–9.
- [12] 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.
- [13] Clavien PA, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. *Surgery* 1992;111:518–26.
- [14] Shabsigh A, Korets R, Vora KC, et al. Defining early morbidity of radical cystectomy for patients with bladder cancer using a standardized reporting methodology. *Eur Urol* 2009;55:164–76.
- [15] Schumacher MC, Jonsson MN, Wiklund NP. Robotic cystectomy. *Scand J Surg* 2009;98:1–17.
- [16] Hasson HM, Rotman C, Rana N, Kumari NA. Open laparoscopy: 29-year experience. *Obstet Gynecol* 2000;96:763–6.
- [17] Nilsson AE, Carlsson S, Laven BA, Wiklund NP. Karolinska prostatectomy: a robot-assisted laparoscopic radical prostatectomy technique. *Scand J Urol Nephrol* 2006;40:453–8.
- [18] Stein JP, Skinner DG. Results with radical cystectomy for treating bladder cancer: a ‘reference standard’ for high-grade, invasive bladder cancer. *BJU Int* 2003;92:12–7.
- [19] Van Velthoven RF, Ahlering TE, Peltier A, Skarecky DW, Clayman RV. Technique for laparoscopic running urethrovesical anastomosis: the single knot method. *Urology* 2003;61:699–702.
- [20] Studer UE, Ackermann D, Casanova GA, Zingg EJ. Three years’ experience with an ileal low pressure bladder substitute. *Br J Urol* 1989;63:43–52.
- [21] Seldinger SI. Catheter replacement of the needle in percutaneous arteriography; a new technique. *Acta Radiol* 1953;39:368–76.
- [22] Nix J, Smith A, Kurpad R, Nielsen ME, Wallen EM, Pruthi RS. Prospective randomized controlled trial of robotic versus open radical cystectomy for bladder cancer: perioperative and pathologic results. *Eur Urol* 2010;57:196–201.
- [23] Stein JP. The role of lymphadenectomy in patients undergoing radical cystectomy for bladder cancer. *Curr Oncol Rep* 2007;9:213–21.
- [24] Leissner J. Lymphadenectomy for bladder cancer. Diagnostic and prognostic significance as well as therapeutic benefit [in German]. *Urologe A* 2005;44:638–44.
- [25] Fleischmann A, Thalmann GN, Markwalder R, Studer UE. Extracapsular extension of pelvic lymph node metastases from urothelial carcinoma of the bladder is an independent prognostic factor. *J Clin Oncol* 2005;23:2358–65.
- [26] Kauffman EC, Ng CK, Lee MM, Otto BJ, Wang GJ, Scherr DS. Early oncologic outcomes for bladder urothelial carcinoma patients treated with robotic-assisted radical cystectomy. *BJU Int* 2011;107:628–35.
- [27] Dasgupta P, Rimington P, Murphy D, et al. Robotic assisted radical cystectomy: short to medium-term oncologic and functional outcomes. *Int J Clin Pract* 2008;62:1709–14.
- [28] Pruthi RS, Wallen EM. Is robotic radical cystectomy an appropriate treatment for bladder cancer? Short-term oncologic and clinical follow-up in 50 consecutive patients. *Urology* 2008;72:617–20, discussion 620–2.