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Analysis of Complications After Robot-Assisted Radical Cystectomy Between 2002-2021

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OBJECTIVE	To identify trends in complications following robot-assisted radical cystectomy (RARC) using a multi-institutional database, the International Robotic Cystectomy Consortium (IRCC).
METHODS	A retrospective review of the IRCC database was performed (2976 patients, 26 institutions from 11 countries). Postoperative complications were categorized as overall or high grade (\geq Clavien Dindo III) and were further categorized based on type/organ site. Descriptive statistics was used to summarize the data. Multivariate analysis (MVA) was used to identify variables associated with overall and high-grade complications. Cochran-Armitage trend test was used to describe the trend of complications over time.
RESULTS	1777 (60%) patients developed postoperative complications following RARC, 51% of complications occurred within 30 days of RARC, 19% between 30-90 days, and 30% after 90 days. 835 patients (28%) experienced high-grade complications. Infectious complications (25%) were the most prevalent, while bleeding (1%) was the least. The incidence of complications was stable between 2002-2021. Gastrointestinal and neurologic postoperative complications increased significantly ($P < .01$, for both) between 2005 and 2020 while thromboembolic ($P = .03$) and wound complications ($P < .01$) decreased. On MVA, BMI (OR 1.03, 95%CI 1.01-1.05, $P < .01$), prior abdominal surgery (OR 1.26, 95%CI 1.03-1.56, $P = .03$), receipt of neobladder (OR 1.52, 95%CI 1.17-1.99, $P < .01$), positive nodal disease (OR 1.33, 95%CI 1.05-1.70, $P = .02$), length of inpatient stay (OR 1.04, 95%CI 1.02-1.05, $P < .01$) and ICU admission (OR 1.67, 95%CI 1.36-2.06, $P < .01$) were associated with high-grade complications.
CONCLUSION	Overall and high-grade complications after RARC remained stable between 2002-2021. GI and neurologic complications increased, while thromboembolic and wound complications decreased. UROLOGY 00: 1–7, 2022. Published by Elsevier Inc.

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Bladder cancer is the 6th most common cancer in the United States with over 80,000 new cases and 17,000 expected deaths in 2021.¹ Radical cystectomy with pelvic lymphadenectomy and urinary diversion remains the gold standard for muscle invasive (MIBC) and refractory non-muscle invasive bladder cancer (NMIBC). The utilization of robot assisted radical cystectomy (RARC) increased by 25-fold between 2003 and 2012, and the proportion of cystectomies performed with robotic assistance increased from 0.6% in 2004 to 32% in 2017.² While RARC has been criticized for its steep learning curve and high cost, prior studies have demonstrated improved perioperative outcomes and recovery times compared to open radical cystectomy.³ Nevertheless, with either approach, radical cystectomy remains a

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highly morbid surgery, with 25%-66% 30-day and 35%-62% 90-day complication rates.⁴⁻⁶ Few studies reported complications beyond 90 days following RARC which may underestimate the actual burden of RARC, especially when up to two-thirds of interventions for complications occur past this timeframe.⁷ In this context, we sought to identify the trends in complications over time in RARC using a prospectively maintained, multi-institutional database, the International Robotic Cystectomy Consortium (IRCC).

METHODS

We retrospectively reviewed 4,015 patients from over 30 institutions in the IRCC database (I-79606) between 2002 and 2021. Patients were excluded if they underwent salvage, palliative, or simple cystectomy. The final cohort comprised 2,976 patients from 26 institutions across 11 countries who underwent RARC since 2002. Patients who developed postoperative complications were identified. Complications were further analyzed and their trend over time was described.

Descriptive statistics was used to depict demographics (age, race, sex, BMI, Charlson Comorbidity Index (CCI) and American Society of Anesthesiologists (ASA) scores, preoperative data (neoadjuvant chemotherapy (NAC), prior radiation therapy, previous abdominal surgery, hydronephrosis, clinical TNM staging, and total days diagnosed, perioperative characteristics (blood loss, transfusion, operative time, lymph node yield [LNY], diversion type, approach, inpatient and ICU stay, and cystectomy era), and postoperative characteristics (pathological staging, lymph node yield, readmission, complications, surgical margins, adjuvant treatment, and death). Complications were described in terms of timing (within 30 days, 30-90 days and >90 days), type (organ site) and grade (categorized as high grade if \geq Clavien Dindo III).

Univariate and multivariate logistic regression models were used to evaluate perioperative and postoperative variables associated with overall complications and high-grade complications. Variables included in the models were: age, gender, body mass index (BMI), race, receipt of neoadjuvant chemotherapy, American Society of Anesthesiologists (ASA) Score \geq 3, prior radiation therapy, previous abdominal surgery, Charlson Comorbidity Index score, preoperative hydronephrosis, Admission to the intensive care unit (ICU), length of inpatient stay, blood transfusion, lymph node yield, diversion type and approach, estimated blood loss, operative time, presence of variant histology, postoperative tumor grade, pT stage, pN+ and surgical margins. Cochran-Armitage trend test was used to depict change in complications over time based on urinary diversion approach, receipt of neoadjuvant chemotherapy, overall complications, and complications by type. Statistical significance was defined as $P \leq .05$. All tests were double-sided. SAS 9.4 (SAS Institute, Cary, NC, USA) was utilized for all analyses.

RESULTS

A total of 1777 (60%) patients developed postoperative complications following robot-assisted radical cystectomy. Median follow-up time was 2 years (IQR 1 - 6). Patients who developed complications underwent prior abdominal surgery more frequently (48% vs 38%, $P < .01$), received NAC less often (23%

vs 27%, $P = .03$), had cardiovascular disease (22% vs 15%, $P < .01$), and prior venous thrombosis (6% vs 4%, $P = .03$) more often. More patients in the complications group received neobladders (22% vs 18%, $P = .04$). They had lymph node yield \geq 20 more frequently (44% vs 37%, $P < .01$), longer inpatient stay (9 vs 7 days, $P < .01$) and more frequent reoperations within 30 days (8% vs 1%, $P < .01$). They exhibited variant histology (25% vs 19%, $P < .01$) and underwent adjuvant treatment within 90 days (6% vs 2%, $P < .01$) more frequently. They experienced higher 30-day (1% vs 0.3%, $P = .01$), 90-day (4% vs 2%, $P < .01$) and overall mortality (35% vs 26% $P < .01$). They were operated upon at institutions with higher annual volume of RARC (21 vs 17 cases/year, $P < .01$) (Table S1 and Table S2).

Of all complications, 51% occurred within 30 days, 19% between 30-90 days, and 30% 90 days after RARC. The median time to any complication was 1 month (range 0 - 152). Twenty eight percent developed high grade complications. Forty-five percent of high-grade complications occurred within 30 days, 19% within 30-90 days, and 36% after 90 days of RARC. Infectious (25%), gastrointestinal (GI) (18%) and genitourinary (GU) (18%) complications were the most common, whereas pulmonary (5%), venous thromboembolic (VTE) (4%), cardiovascular (3%), neurological (3%), and bleeding (1%) were the lowest (Table 1).

The incidence of overall ($P = .98$) and high-grade complications ($P = .07$) were stable between 2004 and 2021 (Fig. 1). Nevertheless, GI complications increased from 14% to 22% ($P < .01$), and neurologic complications from 1% to 5% ($P <$

Table 1. Complications defined in terms of timing, grade and type

	Number of Complications (%)		
Any Complication			
Total	4433		
Within 30	2246 (51)		
30-90 d	863 (19)		
After 90	1324 (30)		
High-grade Complication			
Total	1333		
Within 30	595 (45)		
30-90 d	262 (19)		
After 90	476 (36)		
	Number of patients (%)		
Complication Type			
Complication, Wound	276 (9)		
Complication, Infection	745 (25)		
Complication, Pulmonary	150 (5)		
Complication, Cardiovascular	96 (3)		
Complication, Gastrointestinal	545 (18)		
Complication, Genitourinary	546 (18)		
Complication, Thromboembolism	118 (4)		
Complication, Neurologic	77 (3)		
Complication, Bleeding	38 (1)		
Grade Trend			
	30 d	90 d	Any
Grade \geq 2	955 (32)	1162 (39)	1475 (50)
Grade \geq 3	406 (14)	556 (19)	835 (28)
Grade \geq 4	96 (3)	126 (4)	178 (6)

TRENDS IN COMPLICATIONS BY GRADE

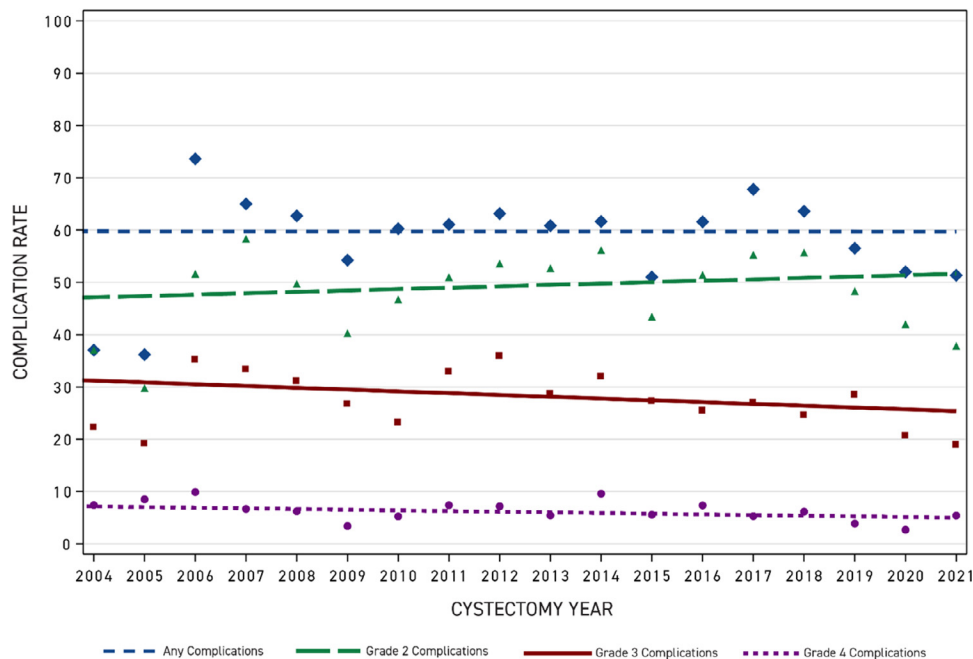


Figure 1. Trends of complications following RARC between 2004 and 2021. Any complications (P -value: .98), high-grade complications (P -value: .07).

.01) (Table S3). On the other hand, VTE decreased from 5% to 3% ($P = .03$) and wound complications from 13% to 6% ($P < .01$) (Fig. 2). During the same period, age of patients undergoing RARC ($P = .02$), CCI ($P < .01$), utilization of NAC ($P < .01$), and intracorporeal diversion ($P < .01$) significantly increased while neobladder utilization decreased ($P < .01$) (Fig. S1). Overall complications at 30 and 90 days ($P < .0001$ for both) significantly increased between 2004 and 2021, while high-grade complications at 30 days and 90 days did not significantly change ($P = .32$ and $.96$, respectively) (Figs. S2 and S3). Thirty- and 90-day mortality rates did not change over time (Fig. S4).

On multivariate analysis, BMI (OR 1.04, 95%CI 1.02-1.06, $P < .01$), prior abdominal surgery (OR 1.44, 95%CI 1.14-1.80, $P < .01$), lymph node yield (OR 1.02, 95%CI 1.01-1.03, $P < .01$), length of inpatient stay (OR 1.10, 95%CI 1.07-1.12, $P < .01$), and ICU admission (OR 1.75, 95%CI 1.37-2.23, $P < .01$) were associated with development of any complication. BMI (OR 1.03, 95%CI 1.01-1.05, $P < .01$), prior abdominal surgery (OR 1.26, 95%CI 1.03-1.56, $P = .03$), receipt of neobladder (OR 1.52, 95%CI 1.17-1.99, $P < .01$), and positive nodal status (OR 1.33, 1.05-1.70, $P = .02$), length of inpatient stay (OR 1.04, 1.02-1.05, $P < .01$), and ICU admission (OR 1.67, 95%CI 1.36-2.06, $P < .01$) were associated with high grade complications (Table 2).

DISCUSSION

Despite advances in surgical technique, RARC remains a highly morbid procedure with more than half of patients developing complications and close to one-third of patients developing high grade complications. In our cohort, 30-day, 90-day, and overall mortality were significantly higher for patients who experienced complications compared to those who did not. The most common were

infectious complications, experienced by 25% of our cohort after RARC, followed by GI (18%) and GU (18%) complications. While complications following RARC have remained relatively stable, GI and neurologic complications have increased over time in contrast to a decrease in wound and VTE complications. In agreement with our findings, the iROC trial (intracorporeal RARC vs. open radical cystectomy) showed significantly lower rates of thromboembolic (1.9% vs 8.3%) and wound complications (5.6% vs 16.0%) in favor of the robotic approach.⁸ While most of the previous studies reported complications up to 3 months after cystectomy, the current analysis shows that almost one-third of complications occur after 90-days of surgery, highlighting the importance of continued follow up and expanding complication reporting.

In the current study, patients who developed complications had history of cardiovascular disease or VTE more often. A multi-institutional group previously reported that cardiovascular comorbidity was a significant factor for overall as well as major complications.⁹ Tikkinen et al. estimated a 4 times increased risk of developing VTE following urologic surgery in patients with prior history of VTE.¹⁰ In agreement with our findings, a prior report from our group found that prior abdominal surgery was associated with 90-day complications. This can be attributed to adhesions that can lead to longer operative times, possible perioperative complications such as injury to adjacent organs, and subsequently prolonged inpatient stay.¹¹

In agreement with previous studies, utilization of neo-adjuvant chemotherapy significantly increased over

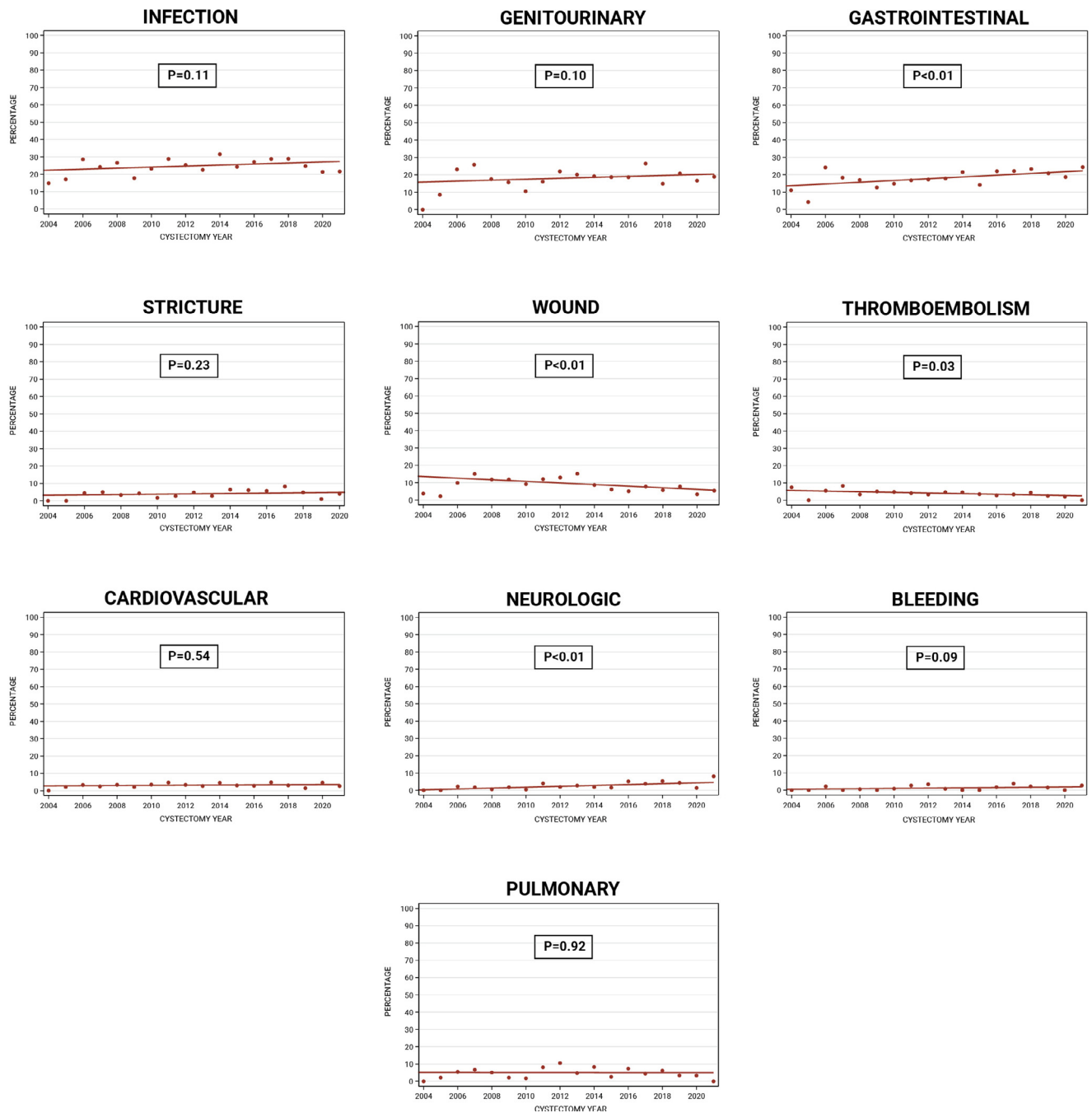


Figure 2. Complications by Type.

time.¹¹ We found that patients who developed complications received NAC less frequently, similar to prior studies.¹¹ In contrast, other studies associated NAC with increased morbidity after radical cystectomy.¹² Variation in the regimens of NAC, dosing, and adverse events reporting may all contribute to these differences and therefore warrants further investigation.

Patients who developed complications received neobladders more frequently and had more frequent reoperations. Neobladders are more complex to perform, require longer operative times, and have been associated with more grade 3-5 complications, that may necessitate further intervention.¹³ These patients also had higher LNY,

harbored variant histology and received adjuvant therapy more frequently. More extensive disease adds to the complexity of the surgical procedure, with more extended node dissection required and possibility of adjuvant chemotherapy and its associated adverse events. Interestingly, institutions with higher volume of RARC exhibited more complications. Previous studies have shown that centralization of care for radical cystectomy has been associated with improved outcomes.¹⁴ However, the increased utilization of neoadjuvant chemotherapy, as well as the broadening of patient selection with comfort with the robotic platform (older patients with multiple comorbidities and more advanced disease) may explain the higher rates of

Table 2. Multivariate analysis depicting variables associated with overall and high-grade complications after RARC

	Odds Ratio (OR)	Lower Confidence Interval	Upper Confidence Interval	P-value
Any Complication				
BMI	1.04	1.02	1.06	<.01
Prior Abdominal Surgery	1.44	1.14	1.80	<.01
Lymph node yield	1.02	1.01	1.03	<.01
Length of Inpatient Stay	1.10	1.07	1.12	<.01
ICU Admission	1.75	1.37	2.23	<.01
High Grade Complication				
BMI	1.03	1.01	1.05	<.01
Prior Abdominal Surgery	1.26	1.03	1.56	.03
Diversion Type, Neobladder	1.52	1.17	1.99	<.01
Positive Nodal Disease	1.33	1.05	1.70	.02
Length of Inpatient Stay	1.04	1.02	1.05	<.01
ICU Admission	1.67	1.36	2.06	<.01

Insignificant Variables: Age; Sex; Race; Receipt of Neoadjuvant Chemotherapy; ASA Score ≥ 3 ; Receipt of Radiation Therapy; Charlson Comorbidity Index Score; Preoperative Hydronephrosis; Receipt of a Transfusion; Number of Lymph Nodes Collected; Diversion Approach (Intra/extra-corporeal); Estimated Blood Loss; Operative Time; Variant Histology; Postoperative Grade; pT Stage; Margins.

complications. In a previous study from our group, there was no significant difference in disease-specific and recurrence-free survival among octogenarians but overall survival was lower.¹⁵ While these findings support that fit older patients should not be deprived RARC, other options, including bladder preservation approaches can still be offered in this setting.¹⁵

Infectious complications remain the most common reason for readmission and contributes to the high costs associated with radical cystectomy. Wittig et al. found that 41% of initial readmissions are related to infections and demonstrated 1.42 times increase in cost for those requiring readmission.¹⁶ Some data suggest that neobladders may be associated with the development of UTI, but this remains controversial.¹⁷ The current study shows an association between neobladder and the development of high-grade complications. Whether administration of prophylactic antibiotics following discharge may decrease UTIs or not remains controversial. A prospective study suggested that prophylactic antibiotic for 1 month after cystectomy may reduce UTIs.¹⁸ A randomized controlled trial is currently recruiting for evaluation of the efficacy of a 30-day antibiotic following discharge (NCT04502095). It remains controversial whether unstented vs stented anastomosis may help with prevention of UTIs.¹⁹ Other studies have suggested culture from stents or administration of prophylactic antibiotic at the time of stent removal.²⁰

The significant increase in GI complications contradicts prior studies who have seen general improvement following the implementation of Enhanced Recovery Programs (ERAS) in cancer care.²¹ Such differences may also be related to the variations in reporting, length of follow-up, difference in diversion approach and type, widening of the selection criteria for patients and operating on more complex patients. This may also be explained by inclusion of higher BMI (29% with BMI > 30, and 68% with BMI > 25), and multiple prior abdominal surgeries (45% of patients), both have been previously associated with GI complications after

RARC.²² The utilization of intracorporeal urinary diversion (ICUD) approaches from a previous IRCC report demonstrated a decrease in GI complications to 10% compared to 23% for extracorporeal diversion, which was not significant in the current analysis.²³

The significant decrease in wound-related complications may be associated with the increase in ICUD approach. Using an ICUD approach results in smaller incisions, and therefore may improve recovery times and decrease the likelihood of dehiscence, incisional hernias, and infected incisions.²⁴ Similarly, VTE complications decreased significantly and accounted for only 4% of all complications. This trend may be explained by the implementation of ERAS and adherence to recommendations for thromboembolic prophylaxis. In a prospectively randomized study, Karl et al. demonstrated a significant improvement in VTE incidence between those who were enrolled in the ERAS program compared to those managed conservatively.²⁵ A meta-analysis study from 2009 demonstrated a significant difference in the incidence of VTE between controls (14%) and those who received prolonged thromboprophylaxis (6%) following abdominal or pelvic surgery.²⁶ Unfortunately, the current study lacks data about the variation and utilization of ERAS protocols among IRCC institutions.

Only 3% of patients in our cohort experienced neurologic deficits despite the significant increase over time. Whether longer operative time and prolonged steep Trendelenburg position, and the associated increase in intracranial pressure (ICP) has any implication is to be investigated. Neurologic complications have been previously reported in 2 case reports after steep Trendelenburg positioning for 7-10 hours.²⁷ Intracranial pressure monitoring may be a consideration for future studies. Additionally, the older patient population may account for increased anesthesia-related risks such as postoperative cognitive dysfunction (POCD).²⁸ More than half of our patients who experienced neurologic complications experienced symptoms similar to POCD including psychosis, confusion, or depression.

Longer inpatient stay and ICU admission were associated with the development of any and high-grade complications. One explanation includes longer hospital admissions for patients who develop complications during their postoperative stay with potential admittance to ICU. One study showed a 136% longer inpatient stay for patients who develop complications.²⁹ Another explanation would be nosocomial infections as a result of prolonged hospital/ICU stay. Healthcare-associated infections can lead to increased length of stay and high hospital costs.³⁰ The Nutrition, Exercise, patient Education, and Wellness (NEEW) pathway established in 2018 enhanced measures recommended by ERAS and effectively reduced hospital and ICU stays.¹⁴ Patients who proceeded under the NEEW pathway experienced fewer high-grade complications within 30-days. Implementation of standardized perioperative pathways is advantageous in improving short-term outcomes and may reduce hospital costs in the long-term.

Our study is not without limitations. Firstly, although IRCC data has been collected in a prospective manner, retrospective analysis has its inherent limitations. Secondly, the IRCC is multi-institutional and relies on the data collected from surgeons with various expertise, differing patient selections, and varied institutional protocols and volumes. Thirdly, while assessment of complications over time can serve as an approximate surrogate for the learning curve of surgeons, addressing the effect of learning curve remains limited. Lastly, the IRCC consists mostly of referral centers and some complications may be missed if patients present to their local provider for management. However, to our knowledge this is the first and largest multi-institutional study to provide insight into the changes in complications following RARC over time.

CONCLUSION

RARC remains a highly morbid procedure. Overall and high-grade complication rates remained stable over time, despite increase in age, NAC, ICUD and neobladder. While GU and neurologic complications significantly increased, wound and VTE complications decreased. High-grade complications were associated with BMI, prior abdominal surgery, receipt of neobladder, nodal disease, length of inpatient stay, and ICU admission.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.urology.2022.08.049>.

References

- Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2021. *CA Cancer J Clin.* 2021;71:7–33.
- Gill IS, Cacciamani GE. 498 - The changing face of urologic oncologic surgery from 2000-2018 (63 141 patients) - impact of robotics. *Eur Urol Suppl.* 2019;18:e656–e657.
- Hussein AA, Elsayed AS, Aldhaam NA, et al. Ten-year oncologic outcomes following robot-assisted radical cystectomy: results from the international robotic cystectomy consortium. *J Urol.* 2019; 202:927–935.
- Lee CU, Kang M, Kim TJ, et al. Predictors of postoperative complications after robot-assisted radical cystectomy with extracorporeal urinary diversion. *Cancer Manag Res.* 2019;11:5055–5063.
- Calderon LP, Al Hussein Al Awamlh B, Shoaq J, Patel Neal, Nicolas JD, Scherr DS. The role of surgical experience in patient selection, surgical quality, and outcomes in robot-assisted radical cystectomy. *Urol Oncol: Semin Orig Invest.* 2021;39:6–12.
- Kimura S, Iwata T, Foerster B, et al. Comparison of perioperative complications and health-related quality of life between robot-assisted and open radical cystectomy: a systematic review and meta-analysis. *Int J Urol.* 2019;26:760–774.
- Hussein AA, Hinata N, Khan N, et al. Does Robot-Assisted Approach to Radical Cystectomy Influence Surgeon Choice for Urinary Diversion? *J Urol Nephrol Open Access.* 2016;2:1–5.
- Catto JWF, Khetrapal P, Ricciardi F, et al. Effect of robot-assisted radical cystectomy with intracorporeal urinary diversion vs open radical cystectomy on 90-day morbidity and mortality among patients with bladder cancer: a randomized clinical trial. *JAMA.* 2022;327:2092–2103.
- Takada N, Abe T, Shinohara N, et al. Peri-operative morbidity and mortality related to radical cystectomy: a multi-institutional retrospective study in Japan. *BJU Int.* 2012;110:E756–E764.
- Tikkanen KAO, Craigie S, Agarwal A, et al. Procedure-specific risks of thrombosis and bleeding in urological cancer surgery: systematic review and meta-analysis. *Eur Urol.* 2018;73:242–251.
- Aldhaam NA, Elsayed AS, Jing Z, et al. Neoadjuvant chemotherapy is not associated with adverse perioperative outcomes after robot-assisted radical cystectomy: a case for increased use from the IRCC. *J Urol.* 2020;203:57–61.
- Johar RS, Hayn MH, Stegemann AP, et al. Complications after robot-assisted radical cystectomy: results from the international robotic cystectomy consortium. *Eur Urol.* 2013;64:52–57.
- Hautmann RE, de Petriconi RC, Volkmer BG. 25 Years of experience With 1,000 neobladders: long-term complications. *J Urol.* 2011;185:2207–2212.
- Aldhaam NA, Elsayed AS, Hussein AA, et al. Impact of perioperative multidisciplinary rehabilitation pathway on early outcomes after robot-assisted radical cystectomy: a matched analysis. *Urology.* 2021;147:155–161.
- Elsayed AS, Aldhaam NA, Brownell J, et al. Perioperative and oncological outcomes of robot-assisted radical cystectomy in octogenarians. *J Geriatr Oncol.* 2020;11:727–730.
- Wittig K, Ruel N, Barlog J, et al. Critical analysis of hospital readmission and cost burden after robot-assisted radical cystectomy. *J Endourol.* 2016;30:83–91.
- Mano R, Goldberg H, Stabholz Y, et al. Urinary tract infections after urinary diversion-different occurrence patterns in patients with ileal conduit and orthotopic neobladder. *Urology.* 2018;116:87–92.
- Wertz RP, Martinez-Acevedo A, Amadi H, et al. Prophylactic antibiotics following radical cystectomy reduces urinary tract infections and readmission for sepsis from a urinary source. *Urol Oncol.* 2018;36:238.e1–238.e5.
- Donat SM, Tan KS, Jibara G, Dalbagni G, Carlon VA, Sandhu J. Intraoperative ureteral stent use at radical cystectomy is associated with higher 30-day complication rates. *J Urol.* 2021;205:483–490.
- Kolwijck E, Seegers AEM, Tops SCM, van der Heijden AG, Sedelaar JPM, Ten Oever J. Incidence and microbiology of post-operative infections after radical cystectomy and ureteral stent removal; a retrospective Cohort Study. *BMC Infect Dis.* 2019;19:303.
- Bazargani ST, Djaladat H, Ahmadi H, et al. Gastrointestinal complications following radical cystectomy using enhanced recovery protocol. *Eur Urol Focus.* 2018;4:889–894.
- Hollenbeck BK, Miller DC, Taub D, et al. Identifying risk factors for potentially avoidable complications following radical cystectomy. *J Urol.* 2005;174(4, Part 1):1231–1237.

23. Ahmed K, Khan SA, Hayn MH, 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;65:340–347.
24. Tanneru K, Jazayeri SB, Kumar J, et al. Intracorporeal versus extracorporeal urinary diversion following robot-assisted radical cystectomy: a meta-analysis, cumulative analysis, and systematic review. *J Robotic Surg.* 2021;15:321–333.
25. Karl A, Buchner A, Becker A, et al. A new concept for early recovery after surgery for patients undergoing radical cystectomy for bladder cancer: results of a prospective randomized study. *J Urol.* 2014;191:335–340.
26. Rasmussen MS, Jørgensen LN, Wille-Jørgensen P. Prolonged thromboprophylaxis with low molecular weight heparin for abdominal or pelvic surgery. *Cochrane Database Syst Rev.* 2009 Cd004318.
27. Pandey R, Garg R, Darlong V, Punj J, Chandralekha, Kumar A. Unpredicted neurological complications after robotic laparoscopic radical cystectomy and ileal conduit formation in steep trendelenburg position: two case reports. *Acta Anaesthesiol Belg.* 2010;61:163–166.
28. Rundshagen I. Postoperative cognitive dysfunction. *Deutsches Arzteblatt Int.* 2014;111:119–125.
29. Lagoe RJ, Johnson PE, Murphy MP. Inpatient hospital complications and lengths of stay: a short report. *BMC Res Notes.* 2011;4:135.
30. Danna DM. Hospital costs associated with sepsis compared with other medical conditions. *Crit Care Nurs Clin North Am.* 2018;30:389–398.

EDITORIAL COMMENT

This multi-institutional study includes nearly 3,000 patients and provides complication rates following robotic-assisted radical cystectomy (RARC) with median follow-up of 2 years. Strengths of this study include large study population, longitudinal analysis (2002–2021), and inclusion of complications beyond the commonly used 30 or 90-day time periods. Based on their results, 30% of patients experienced any complication and 36% experienced high-grade complications after 90-days and these would not be captured in other series examining 90-day or less morbidity and mortality.

The authors report an overall complication rate of 60% and demonstrate that the most common complications were gastrointestinal (GI), genitourinary and infectious, both of which are consistent with prior studies including the recently published iROC trial.^{1–3} Interestingly, the rate of complications in this study remained stable over nearly 20 years although I might expect a decreasing complication rate as robotic experience increases. This could be explained by expanding patient selection criteria over time, with increasingly complex patients undergoing RARC as surgeons gain more comfort with the robotic approach. With 26 institutions included in this study, there may be significant variation in surgical approach and experience across surgeons and institutions, which limits interpretation of the results.

This study demonstrated that thromboembolic and wound complications significantly decreased over time, an expected finding given increasing use of intracorporeal diversions with subsequent

smaller incisions and implementation of ERAS pathways, which emphasize extended VTE prophylaxis.^{3,4} The authors do not offer a convincing explanation for why GI and neurologic complications have increased over the study time period and this may be an area that warrants further investigation. ERAS pathways include multiple measures to improve GI function after cystectomy, including administration of alvimopan, avoidance of bowel preparations, early advancement of diet, and early ambulation, which have improved GI outcomes.⁴ Furthermore, this study reported that patients treated at institutions with higher volume of RARC experienced more complications. Although tertiary care centers may treat more complex patients, this data is in contrast to prior studies showing improved outcomes for cystectomy patients treated at high volume centers.⁵

Overall, this study provides complication rates for RARC, which can be used for patient counseling to improve expectations following RARC. Furthermore, this study provides reasonable rates for which surgeons can compare their own outcomes with. Unfortunately, many variables that were associated with higher complication rates on multi-variable analysis are not easily modifiable (ie prior abdominal surgery, positive nodal disease), and future efforts should be directed toward improving outcomes for patients with these risk factors.

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References

1. Catto JWF, Khetrpal P, Ricciardi F, et al. Effect of robot-assisted radical cystectomy with intracorporeal urinary diversion vs open radical cystectomy on 90-day morbidity and mortality among patients with bladder cancer: a randomized clinical trial. *JAMA.* 2022;327:2092–2103. <https://doi.org/10.1001/jama.2022.7393>.
2. 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;391:2525–2536. [https://doi.org/10.1016/S0140-6736\(18\)30996-6](https://doi.org/10.1016/S0140-6736(18)30996-6).
3. Hussein AA, Elsayed AS, Aldhaam NA, et al. A comparative propensity score-matched analysis of perioperative outcomes of intracorporeal vs extracorporeal urinary diversion after robot-assisted radical cystectomy: results from the International robotic cystectomy consortium. *BJU Int.* 2020;126:265–272. <https://doi.org/10.1111/bju.15083>.
4. Azhar RA, Bochner B, Catto J, et al. Enhanced recovery after urological surgery: a contemporary systematic review of outcomes, key elements, and research needs. *Eur Urol.* 2016;70:176–187. <https://doi.org/10.1016/j.eururo.2016.02.051>.
5. Scarberry K, Berger NG, Scarberry KB, et al. Improved surgical outcomes following radical cystectomy at high-volume centers influence overall survival. *Urol Oncol.* 2018;36:308.e11–308.e17. <https://doi.org/10.1016/j.urolonc.2018.03.007>.

<https://doi.org/10.1016/j.urology.2022.08.052>
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