Risk Factors for Severe 30-d Complications After Minimally Invasive Radical Cystectomy With Ileal Conduit

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Research

Keywords: Complication, Radical cystectomy, Minimally invasive, Clavien-Dindo classification

DOI: https://doi.org/10.21203/rs.3.rs-111286/v1

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Abstract

Background: To investigate the risk factors for severe complications within 30 days in patients receiving minimally invasive radical cystectomy with ileal conduit (MIRCIC).

Methods: 270 consecutive patients who underwent MIRCIC between January 1, 2013 and August 1, 2020 were included. All complications were graded according to the Clavien-Dindo classification (CDC). The comprehensive complication index (CCI) for all complications in each patient was calculated. CDC ≥ II or CCI > 33.7 were considered to be severe complications. Univariate and multivariate analysis were conducted by SPSS26.

Results: A total of 691 complications were collected from 236 patients and the corresponding overall complications rate was 87.41% (236/270). Patients with CDC ≥ II accounted for 23.70% and the incidence of CCI > 33.7 was 22.96%. For the highest CDC grade ≥ III, in univariate analysis, the following seven variants were enrolled in a multivariate analysis: BMI (P=0.010), baseline albumin (P=0.065), pT (P=0.082), pN (P=0.026), pTNM (P=0.016), intraoperative blood transfusion (P=0.031), estimated blood loss (P=0.001). In multivariate analysis, BMI ≥ 30kg/m² (P=0.012) and estimated blood loss ≥ 400ml (P=0.005) were the independent risk factors of CDC ≥ II. Hydronephrosis (P=0.050), BMI (P=0.006), pT (P=0.004), pN (P=0.019), pTNM (P=0.000), operative time (P=0.030), estimated blood loss (P=0.001) were the relevant factors in CCI > 33.7. However, BMI ≥ 30kg/m² (P=0.004) and estimated blood loss (P=0.002) were the independent risk factors of CCI > 33.7.

Conclusion: BMI ≥ 30kg/m² and estimated blood loss ≥ 400ml were found to be independent predictors of 30-d severe complications (CDC ≥ II or CCI > 33.7) in patients who underwent MIRCIC.

Background

Bladder cancer is the 10th most common malignant tumor in the world, ranking the 9th among the cause of cancer death in men[1]. Nowadays, minimally invasive radical cystectomy (MIRC), including laparoscopic and robot-assisted radical cystectomy (LRC and RARC), has been an important therapeutic strategy for patients with bladder cancer[2-9]. The choice of urinary diversion following radical cystectomy is closely related to postoperative complications and life quality of patients. Ureterocutaneostomy is the simplest and safest option of incontinent diversion for selected patients, such as single kidney or limited life expectancy[10,11]. Ileal conduit and orthotopic neobladder are the two most commonly used methods[10], while the trend of the latter is gradually decreasing as it is more suitable for young and healthy male patients[12]. By using a strictly defined complication catalog, Vetterlein et al. reported a 99.4% complication rate within 30 days after radical cystectomy, containing 84% of grade II/III complications that may not impair the rehabilitation process[13]. Therefore, it is of more clinical value to analyze the occurrence of severe complications. The Clavien-Dindo classification (CDC)[14] and comprehensive complication index (CCI)[15] are two of the most commonly used measures of postoperative morbidity. The main objective of our research is to investigate the risk factors for severe complications within 30 days in patients receiving minimally invasive radical cystectomy with ileal conduit (MIRCIC).

Methods

Patients, Data and Definitions

This was an observational study approved by the institutional review board. 270 records of MIRCIC between January 1, 2013 and August 1, 2020 were retrieved from the electronic medical database of the Second Xiangya Hospital of Central South University. The indications for MIRCIC include muscle-invasive (T2-T4a,N0-x,M0) and high-risk non-muscle-invasive bladder cancer. The operations were performed by three surgeons proficient in both LRC and RARC. Data were reviewed in terms of clinical, surgical and pathological variables, including gender, age, coronary heart disease, diabetes, hypertension, hydronephrosis, previous abdominal surgery, age-adjusted Charlson comorbidity index (ACCI)[16], American Society of Anesthesiologists (ASA) score, body mass index (BMI), preoperative anemia, baseline albumin, pathological TNM stage (PTNM), positive surgical margin, histological type, lymphatic vascular infiltration, minimally invasive tool, operative time, intraoperative blood transfusion, estimated blood loss and 30-d complications. Postoperative pathological results were staged according to the 8th AJCC Cancer Manual[17]. All complications were graded according to the CDC[14] and the patient’s CDC rating depended on the highest grade of his/her complications. CDC ≥ II
was considered to be severe complications. The CCI values of all complications for each patient were integrated. The calculation formula is: $\text{CCI} = \sqrt{[1] \text{MRVphys} \times \text{MRVpat}} / 2^{[15]}$. CCI > 33.7 was also defined as severe complications$^{[13]}$.

**Surgery**

We performed a five-port technique for both LRC and RARC (one port for the assistant): a 12-mm trocar was placed at 2cm above the navel edge for the camera, the two operating trocar were placed at the navel level with four transverse finger away from the camera port. The forth trocar was placed above the left iliac crest. The last trocar was located on the inner side of the right iliac crest to facilitate the sticking of the ostomy bag. Patient was placed in a steep Trendelenburg (30°) position after establishing the pneumoperitoneum. Severed the ureters close to the bladder; transected seminal vesicles and vas deferens; detached the dorsal side of the bladder and prostate under the Denonvilliers fascia; clipped the superior vesical arteries; separated and severed lateral ligament of bladder; transected and severed the dorsal venous complex; divided prostatic apex and urethra. The excision for women covers the uterus, fallopian tubes, ovaries, bladder, front vaginal wall and urethra. All patients underwent extracorporeal ileal conduit and standard pelvic lymph node dissection$^{[10]}$.

**Statistical analysis**

Categorical variables were presented as the frequency (ratio). Univariate analysis was performed by using chi-square test or fisher exact method, and factors with $p < 0.1$ were admitted into multivariate analysis, which was performed by binary logistic regression model. IBM SPSS26 statistics software was used for statistical analysis and $p < 0.05$ suggested a statistical difference in the study.

**Results**

Table 1 describes all 30-d complications, therapeutic managements and CDC grades in 270 patients with MIRCIC. None of patients received neoadjuvant chemoradiotherapy and open conversion. A total of 691 complications were collected from 236 patients: 366 cases of CDC$^{a}$, 240 cases of CDC$^{b}$, 53 cases of CDC$^{a}$, 19 cases of CDC$^{b}$, 9 cases of CDC$^{a}$ and 4 cases of CDC$^{b}$ (Fig1-A). So the corresponding overall complications rate was 87.41% (236/270). Urinary tract infection was the most common postoperative complication (34.44%, 93/270), followed by intestinal obstruction (21.48%, 58/270). There were 85 complications of CDC$^{\geq}$ in 64 patients and the severe complications rate was a 23.70% (64/270), including 40 cases of intestinal obstruction, 3 cases of gastrointestinal bleeding, 6 cases of small bowel leakage, 1 case of rectal rupture, 10 cases of wound dehiscence, 2 cases of intraperitoneal infection, 1 case of scrotal abscess, 1 case of congestive heart failure, 1 case of shock, 4 cases of death, 3 cases of lymphatic leakage, 3 cases of urinary leakage, 6 cases of acute kidney failure, 3 cases of respiratory failure and 1 case of foreign body in the urethra. Figures 1-B exhibits the association between the highest CDC grade of 30-d complications and CCI. Figures 1-C presents the connection between numbers of complications and CCI. The proportion of CCI > 33.7 was 22.96% (62/270).

For the highest CDC grade $\geq 3$, in univariate analysis, the following seven variants were enrolled in the multivariate analysis: BMI (P=0.010), baseline albumin(P=0.065), pT (P=0.082), pN (P=0.026), pTNM (P=0.016), intraoperative blood transfusion (P=0.031), estimated blood loss (P=0.001). Hydronephrosis (P=0.050), BMI (P=0.006), pT (P=0.004), pN (P=0.019), pTNM (P=0.000), operative time (P=0.030), estimated blood loss (P=0.001) were the relevant factors in CCI > 33.7 (Table 2).

In multivariate analysis, BMI $\geq 30$kg/m$^2$ (P=0.012) and estimated blood loss $\geq 400$ml (P=0.005) were the independent risk factors of CDC$^{\geq 3}$ (Table 3). Likewise, BMI $> 30$kg/m$^2$(P=0.004) and estimated blood loss (P=0.002) were the independent risk factors of CCI $> 33.7$ (Table 4).

**Discussion**

MIRC has become a mainstream surgical option for bladder cancer patients with curative intent in most medical centers, because its effectiveness and safeness have been well demonstrated, namely less pain, smaller trauma and quicker recovery$^{[2-9]}$. The history of LRC can be traced back to 1992$^{[18]}$, despite the advantages mentioned above, it has a higher demand on surgeons both in anatomical knowledge and endoscopic skills. The first robotic surgery system was approved into clinical use in 1994$^{[19]}$, and surgical robot provides us with flexible mechanical arms and 3-Dimension vision. There was no significant difference in effectiveness and safety between RARC and LRC based on the current pooled evidence: the surgery duration, positive surgical
margin rate, postoperative recovery and complications were comparable for both approaches[20]. Urinary diversion is a critical step after bladder removal and the choice should take into account the patient's wishes, age, underlying diseases, tumor stage and life expectancy. Ileal conduit is one of the most classic and widely used urinary diversion procedures following bladder resection[10,12]. The incidence of overall 30-d complications was 87.41% (236/270) in our center, but CDC grade I and II complications accounted for 87% (606/691). Similarly, a single-center retrospective study captured 2485 complications in 506 patients with a 99.4% (503/506) 30-d complications rate, whereas 84% of them were CDC grade I or II[13]. However, the 30-d complications rates of MIRC in five articles included in a meta-analysis were 41.2% (14/34), 66.7% (26/39), 15% (3/20), 43% (52/121) and 45.5% (5/11), respectively[20]. There was still a distinct discrepancy in reporting of complications after radical cystectomy[21], because those minor complications were neglected by researchers who held such views that single low-level complication doesn't unnecessarily impair the postoperative course of patients. Vetterlein et al pointed out that the occurrence of massive minor complications doesn't mean treatment failure, and detailed documentation of postoperative adverse events that potentially damage recovery and quality of life of patients is essential for patient consultation, clinical trial design and treatment efficiency assessment[13]. Besides, severe complication, which can cause serious physical, psychological and financial harm to patients, is surgeons' greatest concern and patients' least desire. The primary purpose of this study was to investigate risk factors for severe complications within 30 days after MIRCIC.

CDC is currently the most commonly used complication assessment method, and numerous studies incorporate CDC ≥ II into "major complication". A retrospective research of Zhang et al. included 298 cases of MIRC and revealed that the proportion of patients with major complication was 15.1% (45/298)[22]. Su et al. reviewed the clinical data of 126 patients with LRC and 189 patients with RACRC, and found an rate of 7.62% (24/315) about postoperative overall major complications[23]. In contrast, the ratio of patients with CDC ≥ III was higher in our study (23.70%, 64/270). The reason may be that we had an rigorous inclusion criteria for the method of urinary diversion, while 55.7% and 25.7% of other types of diversion were involved in the above two studies, respectively. The occurrence rate of gastrointestinal complications after radical cystectomy was about 29%[24]. Svatek et al. performed a study involving 283 patients undergoing open radical cystectomy and indicated that the incidence of postoperative paralytic ileus was 15.2%[25]. Furthermore, BMI (95%CI: 1.03-1.17, P =.007) and age (95%CI: 1.02-1.16, P =.008) were independent risk factors of paralytic ileus[25]. In this paper, our results confirmed that the most common major complication was ileus with an rate of 23.70% (64/270), and BMI ≥ 30 kg/m² (95% CI: 1.216 5.032, P = 0.012) and estimated blood loss ≥ 400ml (95% CI: 1.367 5.992, P = 0.005) were the independent predictors of CDC ≥ II. Increased BMI was associated with higher postoperative complication rates, comprising infection-related diseases, wound-related diseases, acute kidney injury and paralytic ileus[26]. In the article of Lenardis et al., the major complication was defined as one of the following postoperative events: cardiac or neurological complications, reoperation and death[27]. Patients with BMI ≥ 30kg/m2 were significantly more likely to undergo major complications within 30 days after radical cystectomy than those with normal BMI(OR 1.59, 95% CI 1.17-2.16)[27]. Likewise, Arora and colleagues published their study with 2055 patients receiving radical cystectomy, and they suggested that a high BMI was highly correlated with 30-d mortality and morbidity[28]. In minimally invasive surgery, even a small amount of bleeding can seriously impair the clarity of operative visual filed due to the magnification of camera lens. Lin et al. conducted a prospective randomized controlled trial and asserted that the application of minimally invasive tool significantly reduced intraoperative blood loss compared to conventional open surgery (215ml vs 510ml, P<0.001)[2]. A latest meta-analysis verified that there was no significant difference in intraoperative blood loss between LRC and RARC (95%CI: -37.81-258.62, P=0.14)[20]. Wilson and workmates retrospectively analyzed the data of 2934 cases and deemed that perioperative blood transfusion was associated with increased morbidity(OR 1.361, 95% CI 1.131-1.638)[29]. Shen et al. concluded that the need for postoperative blood transfusion, rather than intraoperative blood transfusion, was independently associated with perioperative morbidity[30]. Intraoperative blood transfusion was not associated with the rate of 30-d severe complications but estimated blood loss was an independent predictor of 30-d severe complications(CDC ≥ II or CCI > 33.7) in our study(OR 2.862, 95% CI 1.367-5.992; OR 2.904 95% CI 1.497-5.634). Reason may be that intraoperative blood product requirements were closely related to preoperative anaemia[30], while the degree of anemia was relatively mild before surgery in our research, in which the median HB value was 129g/L(interquartile range: 116-140g/L). Secondly, postoperative blood transfusion may be due to massive intraoperative bleeding or other serious complications such as gastrointestinal bleeding, so, the inclusion of it in multiple logistic regression analysis may lead to greater bias.
CCI is a new complication evaluation method developed on the basis of CDC, and it integrates all postoperative complications to obtain the cumulative morbidity, which is conducive to the comprehensive evaluation of patient recovery\cite{15}. CCI values was positively associated with the number and grade of complications, and patients with CCI value exceeding 33.7 accounted for 20\%\cite{13}, which was also verified in this study. In addition, we further confirmed the feasibility of CCI in evaluating severe complications after radical surgery. BMI ≥ 30kg/m² (95%CI: 1.411-6.510, P=0.004) and estimated blood loss ≥ 400ml (95%CI: 1.497-5.634, P=0.002) were also independent risk factors for patients with CCI >33.7. Therefore, it is necessary to evaluate and control BMI before MIRCIC, and to minimize the amount of blood loss during the operation.

Admittedly, there were several limitations to this study. Firstly, Our study was a single-center retrospective study with its inherent drawbacks. Secondly, different surgical habits and treatment ideas among the three surgeons may lead to some bias. Thirdly, the present study only included complications occurring within 30 days after MIRCIC. However, it is indubitably crucial to predict long-term procedure-specific severe complications and survival outcomes. To address these limitations, a multicenter prospective study is necessary. Nevertheless, this study enriches the perioperative data of MIRCIC and provides valuable clinical information for bladder cancer patients and urologists.

**Conclusion**

BMI ≥ 30kg/m² and estimated blood loss ≥ 400ml were found to be independent predictors of 30-d severe complications (CDC ≥ or CCI > 33.7) in patients who underwent MIRCIC.

**Abbreviations**

MIRC= minimally invasive radical cystectomy  
LRC= laparoscopic radical cystectomy  
RARC= robot-assisted radical cystectomy  
CDC= Clavien-Dindo classification  
CCI= comprehensive complication index  
MIRCIC= minimally invasive radical cystectomy with ileal conduit  
ACCI= age-adjusted Charlson comorbidity index  
ASA= American Society of Anesthesiologists  
BMI= body mass index

**Declarations**

**Ethical approval and consent to participate**

This study was approved by the Ethics Review Committee of the Second Xiangya Hospital of Central South University.

**Consent fore publication**

A complete informed consent was obtained from the patient and their families before the surgery. Informed consent was signed for all patients.

**Availability of date and materials**

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

**Competing Interests**
Xiao Ming, Zhong Zhaohui, Ren Jiannan, Xiong Wei have no conflict of interest to declare.

Funding.

No funding was received.

Authors’ contribution

Xiao Ming was responsible for study concepts, study design and the writing of the manuscript. Zhong Zhaohui was responsible for reviewing the article and proposing changes. Ren Jiannan collected and analyzed data. Xiong Wei was responsible for the starring revision of the article and study design. All authors read and approved the final manuscript.

Acknowledgements

The authors thank the nurses, care-givers and hospital workers. Special thanks to my girlfriend, Ms. Kang Lu, who has been quietly supporting me.

References

1. Bray F, Ferlay J, Soerjomataram I, et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries [published correction appears in CA Cancer J Clin. 2020 Jul;70(4):313]. CA Cancer J Clin. 2018;68(6):394-424.
2. Lin T, Fan X, Zhang C, et al. A prospective randomised controlled trial of laparoscopic vs open radical cystectomy for bladder cancer: perioperative and oncologic outcomes with 5-year follow-up. Br J Cancer. 2014;110(4):842-849.
3. Guillotreau J, Gamé X, Mouzin M, et al. Radical cystectomy for bladder cancer: morbidity of laparoscopic versus open surgery. J Urol. 2009;181(2):554-559.
4. Tang K, Li H, Xia D, et al. Laparoscopic versus open radical cystectomy in bladder cancer: a systematic review and meta-analysis of comparative studies. PLoS One. 2014;9(5):e95667.
5. Li K, Lin T, Fan X, et al. Systematic review and meta-analysis of comparative studies reporting early outcomes after robot-assisted radical cystectomy versus open radical cystectomy. Cancer Treat Rev. 2013;39(6):551-560.
6. 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(11):1736-1743.
7. Musch M, Janowski M, Steves A, et al. Comparison of early postoperative morbidity after robot-assisted and open radical cystectomy: results of a prospective observational study. BJU Int. 2014;113(3):458-467.
8. Kim TH, Sung HH, Jeon HG, et al. Oncological Outcomes in Patients Treated with Radical Cystectomy for Bladder Cancer: Comparison Between Open, Laparoscopic, and Robot-Assisted Approaches. J Endourol. 2016;30(7):783-791.
9. Matsumoto K, Tabata KI, Hirayama T, et al. Robot-assisted laparoscopic radical cystectomy is a safe and effective procedure for patients with bladder cancer compared to laparoscopic and open surgery: Perioperative outcomes of a single-center experience. Asian J Surg. 2019;42(1):189-196.
10. Witjes JA, Bruins HM, Cathomas R, et al. European Association of Urology Guidelines on Muscle-invasive and Metastatic Bladder Cancer: Summary of the 2020 Guidelines [published online ahead of print, 2020 Apr 29]. Eur Urol. 2020;S0302-2838(20)30230-X.
11. Kozacıoğlu Z, Değirmenci T, Günlüsoy B, et al. Ureterocutaneostomy: for whom and when?. Turk J Urol. 2013;39(3):143-146.
12. Bachour K, Faiena I, Salmasi A, et al. Trends in urinary diversion after radical cystectomy for urothelial carcinoma. World J Urol. 2018;36(3):409-416.
13. Vetterlein MW, Klemm J, Gild P, et al. Improving Estimates of Perioperative Morbidity After Radical Cystectomy Using the European Association of Urology Quality Criteria for Standardized Reporting and Introducing the Comprehensive Complication Index. Eur Urol. 2020;77(1):55-65.
14. Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg. 2009;250(2):187-196.
15. Slankamenac K, Graf R, Barkun J, et al. The comprehensive complication index: a novel continuous scale to measure surgical morbidity. Ann Surg. 2013;258(1):1-7.

16. Koppie TM, Serio AM, Vickers AJ, et al. Age-adjusted Charlson comorbidity score is associated with treatment decisions and clinical outcomes for patients undergoing radical cystectomy for bladder cancer. Cancer. 2008;112(11):2384-2392.

17. Amin MB, Greene FL, Edge SB, et al. The Eighth Edition AJCC Cancer Staging Manual: Continuing to build a bridge from a population-based to a more "personalized" approach to cancer staging. CA Cancer J Clin. 2017;67(2):93-99.

18. McDougall EM, Clayman RV, Figenshau RS, et al. Laparoscopic retropubic auto-augmentation of the bladder. J Urol. 1995;153(1):123-126.

19. Mettler L, Ibrahim M, Jonat W. One year of experience working with the aid of a robotic assistant (the voice-controlled optic holder AESOP) in gynaecological endoscopic surgery. Hum Reprod. 1998;13(10):2748-2750.

20. Peng L, Li J, Cao D, et al. Can robotic-assisted radical cystectomy provide patients with a smaller trauma and faster recovery period? A systematic review and meta-analysis of comparative trials. J Cancer Res Clin Oncol. 2020;146(6):1591-1601.

21. Novara G, De Marco V, Aragona M, et al. Complications and mortality after radical cystectomy for bladder transitional cell cancer. J Urol 2009;182:914–21.

22. Zhang S, Lin T, Zhang Q, et al. Comparison of perioperative outcomes in robot-assisted radical cystectomy and laparoscopic radical cystectomy. Int J Med Robot. 2020;16(2):e2074.

23. Su S, Gu L, Ma X, et al. Comparison of Laparoscopic and Robot-assisted Radical Cystectomy for Bladder Cancer: Perioperative and Oncologic Outcomes. Clin Genitourin Cancer. 2019;17(5):e1048-e1053.

24. 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(1):164-174.

25. Svatek RS, Fisher MB, Williams MB, et al. Age and body mass index are independent risk factors for the development of postoperative paralytic ileus after radical cystectomy. Urology. 2010;76(6):1419-1424.

26. Omaghi PI, Afferi L, Antonelli A, et al. The impact of preoperative nutritional status on post-surgical complication and mortality rates in patients undergoing radical cystectomy for bladder cancer: a systematic review of the literature [published online ahead of print, 2020 Jun 9]. World J Urol. 2020;10.1007/s00345-020-03291-z.

27. Lenardis M, Harper B, Satkunasivam R, et al. The association between patient body mass index and perioperative outcomes following radical cystectomy: An analysis using the American College of Surgeons National Surgical Quality Improvement Program database. Can Urol Assoc J. 2020;14(9):E412-E417.

28. Arora K, Hanson KT, Habermann EB, et al. Early Complications and Mortality following Radical Cystectomy: Associations with Malnutrition and Obesity. Bladder Cancer. 2018;4(4):377-388.

29. Sui W, Onyeji IC, Matulay JT, et al. Perioperative blood transfusion in radical cystectomy: Analysis of the National Surgical Quality Improvement Program database. Int J Urol. 2016;23(9):745-750.

30. Tan WS, Lamb BW, Khetrapal P, et al. Blood Transfusion Requirement and Not Preoperative Anemia Are Associated with Perioperative Complications Following Intracorporeal Robot-Assisted Radical Cystectomy. J Endourol. 2017;31(2):141-148.

Tables
| Management | CDC grade | Number | Proportion(%) | CDC ≥ | Number | Proportion(%) |
|------------|-----------|--------|---------------|-------|--------|---------------|
| **Gastrointestinal** |
| Intestinal obstruction | total parenteral nutrition/insertion of gastric tube/laparotomy | □ □ | 58 | 21.48 | □ □ | 40 | 14.81 |
| Gastrointestinal bleeding | conservative/blood transfusions/laparotomy | □ □ | 18 | 6.67 | □ □ | 3 | 1.11 |
| Emesis/nausea(without ileus) | antiemetics | □ | 13 | 4.81 | □ □ | 0 | 0 |
| Intestinal leakage/enterobrosis | conservative/cathetering/laparotomy | □ □ | 7 | 2.59 | □ □ | 6 | 2.22 |
| Rectal rupture | laparotomy | □ □ | 1 | 0.37 | □ □ | 1 | 0.37 |
| Diarrhea/constipation | antidiarrheals/cathartic | □ | 21 | 7.78 | □ □ | 0 | 0 |
| Stress ulcer | conservative | □ | 3 | 1.11 | □ □ | 0 | 0 |
| **Infectious** |
| Urinary tract infection | antibiotics | □ | 93 | 34.44 | □ □ | 0 | 0 |
| Wound infection/poor healing | conservative/antibiotics/second surgical closure | □ □ □ | 26 | 9.63 | □ □ □ | 10 | 3.70 |
| Pneumonia | antibiotics | □ □ | 27 | 10.00 | □ □ □ | 0 | 0 |
| Intraperitoneal infection | antibiotics/abdominocentesis | □ □ | 23 | 8.52 | □ □ □ | 2 | 0.74 |
| Scrotitis/scrotal abscess | antibiotics/puncture and drainage | □ □ | 2 | 0.74 | □ □ □ | 1 | 0.37 |
| Fistula infection | antibiotics | □ □ | 1 | 0.37 | □ □ □ | 0 | 0 |
| Catheter-related infection | antibiotics | □ □ | 3 | 1.11 | □ □ □ | 0 | 0 |
| Intestinal infection | antibiotics | □ □ | 3 | 1.11 | □ □ □ | 0 | 0 |
| **Cardiac** |
| Arrhythmia | conservative/medical cardioversion | □ □ | 9 | 3.33 | □ □ □ | 0 | 0 |
| Hypertension | antihypertensives | □ □ □ | 15 | 5.56 | □ □ □ | 0 | 0 |
| Congestive heart failure | ICU | □ □ □ | 1 | 0.37 | □ □ □ | 1 | 0.37 |
| Angina | conservative | □ □ □ | 4 | 1.48 | □ □ □ | 0 | 0 |
| Hypotension/shock | Conservative/cardioactive drugs/ICU | □ □ □ □ | 13 | 4.81 | □ □ □ □ | 1 | 0.37 |
| **Neurological** |
| Vertigo | conservative | □ □ □ | 5 | 1.85 | □ □ □ | 0 | 0 |
| Delirium | antipsychotics | □ □ □ | 5 | 1.85 | □ □ □ | 0 | 0 |
| Transient Ischemic Attacks | conservative | □ □ □ | 2 | 0.74 | □ □ □ | 0 | 0 |
| **Dermatologic** |

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| Condition                  | Treatment        | Incidence | Mortality | Morbidity |
|----------------------------|------------------|-----------|-----------|-----------|
| Dermatitis                 | ointment         | 11        | 0         | 0         |
| Allergy                    | conservative     | 2         | 0         | 0         |
| Pneumoderm                 | conservative     | 2         | 0         | 0         |

**Electrolyte disturbance**

| Condition                  | Treatment        | Incidence | Mortality | Morbidity |
|----------------------------|------------------|-----------|-----------|-----------|
| Hyponatremia               | electrolytes     | 35        | 0         | 0         |
| Hypokalemia                | electrolytes     | 35        | 0         | 0         |
| Hyperkalemia               | conservative     | 7         | 0         | 0         |

**Death**

| Condition                  | Treatment        | Incidence | Mortality | Morbidity |
|----------------------------|------------------|-----------|-----------|-----------|
|                            |                  | 4         | 4         | 1.48      |

**Miscellaneous**

| Condition                  | Treatment        | Incidence | Mortality | Morbidity |
|----------------------------|------------------|-----------|-----------|-----------|
| Urinary leak               | delayed catheter extraction/drainage | 30 | 3 | 1.11 |
| Lymphorrhagia              | delayed catheter extraction/drainage | 54 | 3 | 1.11 |
| Baryodynia                 | analgetics       | 34        | 0         | 0         |
| Hypoglycemia               | sugar            | 6         | 0         | 0         |
| Hyperglycemia              | insulin          | 13        | 0         | 0         |
| Fever of unknown origin    | antipyretics     | 17        | 0         | 0         |
| Liver function damage      | conservative     | 10        | 0         | 0         |
| Gout flare                 | medical therapy  | 3         | 0         | 0         |
| Kidney injury              | conservative/drugs/nephrostomy/dialysis | 45 | 6 | 2.22 |
| Respiratory distress       | conservative/ICU | 6 | 3 | 1.11 |
| Deep vein thrombosis       | anticoagulation  | 11        | 0         | 0         |
| Dental ulcer               | conservative     | 3         | 0         | 0         |
| Hydrocele                  | conservative     | 3         | 0         | 0         |
| Foreign body in urethra    | removal of foreign body | 1 | 1 | 0.37 |
| Ostomy related diseases    | conservative/antibiotics | 6 | 0 | 0 |
| Variables                        | Patients | CDC≥3 | \( \chi^2 \) | P   | CCI>33.7 | \( \chi^2 \) | P   |
|---------------------------------|----------|-------|--------------|-----|----------|--------------|-----|
| Gender                          |          |       |              |     |          |              |     |
| man                             | 238      | 58    | 0.493        | 0.483 | 0.024    | 0.876        |     |
| woman                           | 32       | 6     |              |     |          |              |     |
| Age                             |          |       | 0.040        | 0.841 | 0.023    | 0.881        |     |
| <65                             | 159      | 37    |              |     |          |              |     |
| ≥65                             | 111      | 27    |              |     |          |              |     |
| Coronary heart disease          |          |       | 0.528        | 0.577\(^1\) | 0.432    | 0.772\(^1\) |     |
| no                              | 252      | 61    |              |     |          |              |     |
| yes                             | 18       | 3     |              |     |          |              |     |
| Diabetes                        |          |       | 0.029        | 0.865 | 0.042    | 0.838        |     |
| no                              | 242      | 57    |              |     |          |              |     |
| yes                             | 28       | 7     |              |     |          |              |     |
| Hypertension                    |          |       | 0.053        | 0.819 | 0.203    | 0.653        |     |
| no                              | 172      | 40    |              |     |          |              |     |
| yes                             | 98       | 24    |              |     |          |              |     |
| Hydronephrosis                  |          |       | 0.618        | 0.432 | 3.828    | 0.050        |     |
| no                              | 201      | 45    |              |     |          |              |     |
| yes                             | 69       | 19    |              |     |          |              |     |
| Previous abdominal surgery      |          |       | 0.417        | 0.519 | 0.097    | 0.755        |     |
| no                              | 234      | 57    |              |     |          |              |     |
| yes                             | 36       | 7     |              |     |          |              |     |
| ACCCI                           |          |       | 0.073        | 0.787 | 0.052    | 0.819        |     |
| ≤3                              | 199      | 48    |              |     |          |              |     |
| >3                              | 71       | 16    |              |     |          |              |     |
| ASA score                       |          |       | 1.518        | 0.218 | 0.064    | 0.800        |     |
| ≤2                              | 117      | 32    |              |     |          |              |     |
| >2                              | 153      | 32    |              |     |          |              |     |
| BMI                             |          |       | 6.702        | 0.010 | 7.565    | 0.006        |     |
| <30 kg/m\(^2\)                 | 223      | 46    |              |     |          |              |     |
| ≥30 kg/m\(^2\)                 | 47       | 18    |              |     |          |              |     |
| Preoperative anemia             |          |       | 1.061        | 0.303 | 0.075    | 0.785        |     |
| no                              | 191      | 42    |              |     |          |              |     |
| yes                             | 79       | 22    |              |     |          |              |     |
| Baseline albumin               |          |       | 3.408        | 0.065 | 1.860    | 0.173        |     |
|                                    | CDC | CCI | ACCI | ASA | BMI |
|------------------------------------|-----|-----|------|-----|-----|
| <40 g/L                            | 195 | 52  | 49   |     |     |
| ≥40 g/L                            | 75  | 12  | 13   |     |     |
| pT                                 |     |     |      |     |     |
| ≤T2                                | 192 | 40  | 35   |     |     |
| >T2                                | 78  | 24  | 27   |     |     |
| pN                                 |     |     |      |     |     |
| negative                           | 240 | 52  | 50   |     |     |
| positive                           | 30  | 12  | 12   |     |     |
| pTNM                               |     |     |      |     |     |
| ≤†                                 | 181 | 35  | 30   |     |     |
| ≥†                                 | 89  | 29  | 32   |     |     |
| Positive surgical margin           |     |     |      |     |     |
| no                                 | 258 | 59  | 57   |     |     |
| yes                                | 12  | 5   | 5    |     |     |
| Histological type                  |     |     |      |     |     |
| urothelium                         | 251 | 59  | 55   |     |     |
| non-urothelium                     | 19  | 5   | 7    |     |     |
| Lymphatic vascular infiltration    |     |     |      |     |     |
| no                                 | 242 | 56  | 53   |     |     |
| yes                                | 28  | 8   | 9    |     |     |
| Minimally invasive tool            |     |     |      |     |     |
| laparoscope                        | 162 | 42  | 37   |     |     |
| robot                              | 108 | 22  | 25   |     |     |
| Operative time                     |     |     |      |     |     |
| <420min                            | 183 | 40  | 35   |     |     |
| ≥420min                            | 87  | 24  | 27   |     |     |
| Intraoperative blood transfusion   |     |     |      |     |     |
| no                                 | 219 | 46  | 46   |     |     |
| yes                                | 51  | 18  | 16   |     |     |
| Estimated blood loss               |     |     |      |     |     |
| <400mL                             | 202 | 38  | 36   |     |     |
| ≥400mL                             | 68  | 26  | 26   |     |     |

CDC=Clavien-Dindo classification; CCI=comprehensive complication index; ACCI=age-adjusted Charlson comorbidity index; ASA=American Society of Anesthesiologists; BMI=body mass index. 1: fisher exact method
Table 3. Multivariate cox analysis for CDC ≥1

| Variables                  | Wald | OR   | 95%CI          | P    |
|----------------------------|------|------|----------------|------|
| BMI                        | 6.250| 2.474| 1.216-5.032    | 0.012|
| Preoperative albumin       | 3.214| 0.508| 0.242-1.065    | 0.730|
| pT                         | 0.560| 0.547| 0.113-2.654    | 0.454|
| pN                         | 0.805| 1.692| 0.536-5.340    | 0.369|
| pTNM                      | 1.429| 2.885| 0.508-16.393   | 0.232|
| Intraoperative blood transfusion | 0.230| 1.067| 0.464-2.453    | 0.879|
| Estimated blood loss       | 7.779| 2.862| 1.367-5.992    | 0.005|

BMI=body mass index

Table 4. Multivariate cox analysis of CCI>33.7

| Variables                  | Wald | OR   | 95%CI          | P    |
|----------------------------|------|------|----------------|------|
| Hydronephrosis             | 3.772| 2.017| 0.994-4.095    | 0.052|
| BMI                        | 8.083| 3.031| 1.411-6.510    | 0.004|
| pT                         | 0.437| 0.586| 0.120-2.854    | 0.509|
| pN                         | 0.427| 1.466| 0.465-4.622    | 0.514|
| pTNM                      | 2.162| 3.715| 0.646-21.361   | 0.141|
| Operative time             | 2.189| 1.627| 0.854-3.100    | 0.139|
| Estimated blood loss       | 9.943| 2.904| 1.497-5.634    | 0.002|

BMI=body mass index

Figures
Figure 1

(A) Graph diagram presenting all 30-d complications (according to CDC) in 270 patients. (B) Diagram exhibiting the association between the highest CDC grade of 30-d complications and CCI. (C) Chart showing the connection between numbers of complications and CCI. CDC = Clavien-Dindo classification CCI = comprehensive complication index
Figure 1

(A) Graph diagram presenting all 30-d complications (according to CDC) in 270 patients. (B) Diagram exhibiting the association between the highest CDC grade of 30-d complications and CCI. (C) Chart showing the connection between numbers of complications and CCI. CDC= Clavien-Dindo classification CCI= comprehensive complication index