APPENDIX A. SEARCH STRATEGIES

DATABASE SEARCHED & TIME PERIOD COVERED:
PubMed – 1/1/2010-6/29/2019

LANGUAGE:
English

SEARCH STRATEGY #1:
"Similar Article" searches on the following 2 articles:
Systematic review and meta-analysis of randomised trials of perioperative outcomes comparing robot-assisted versus open radical cystectomy.
Shen Z1, Sun Z2.
BMC Urol. 2016 Sep 23;16(1):59.

Robotic versus open partial nephrectomy: a systematic review and meta-analysis.
Wu Z1, Li M2, Liu B1, Cai C3, Ye H1, Lv C1, Yang Q1, Sheng J2, Song S1, Qu L1, Xiao L1, Sun Y1, Wang L1.
PLoS One. 2014 Apr 16;9(4):e94878. doi: 10.1371/journal.pone.0094878. eCollection 2014.

SEARCH STRATEGY #2:
Robotic Surgical Procedures"[Mesh] OR robotics[mh] OR robot-assisted OR robot*[tiab] OR robot*[ot]
AND
nephrectom* OR cystectom* OR nephrectomy[mh] OR ureter OR ureteral OR ureters
NOT
editorial[pt] OR editorial[ti] OR letter[pt] OR letter[ti] OR comment[pt] OR comment[ti]

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DATABASE SEARCHED & TIME PERIOD COVERED:
Embase – 1/1/2010-6/29/2019

LANGUAGE:
English

SEARCH STRATEGY:
'robot assisted surgery'/exp OR 'robot assisted surgery' OR 'robot assisted' OR robot*
AND
'cystectomy'/exp OR 'cystectomy' OR 'nephrectomy'/exp OR 'nephrectomy' OR 'ureter'/exp OR ureter OR 'ureters'/exp OR ureters OR ureteral
AND
HUMAN

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DATABASE SEARCHED & TIME PERIOD COVERED:
Cochrane – All databases – 1/1/2010-6/29/2019

LANGUAGE:
English

SEARCH STRATEGY:
MeSH descriptor: [Robotic Surgical Procedures] explode all trees OR MeSH descriptor: [Robotics] explode all trees OR (robotic-assisted OR robot*):ti,ab,kw
AND
MeSH descriptor: [Nephrectomy] explode all trees OR MeSH descriptor: [Cystectomy] explode all trees OR MeSH descriptor: [Ureter] explode all trees OR (nephrectomy* OR cystectomy* OR ureter OR ureteral OR ureters):ti,ab,kw

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NOTE: FOR ALL SEARCH RESULTS, ANIMAL-ONLY STUDIES WERE DELETED MANUALLY IN ENDNOTE

NOTE: FOR ALL SEARCH RESULTS, ENDNOTE SEARCHES WERE DONE ON THE FOLLOWING TERMS INI THE RECORD TITLE OR KEYWORD:
PEDIATRIC(S)
PAEDIATRIC(S)
CHILD(REN)
INFANT(S)

RESULTS WERE REVIEWED AND ARTICLES RELATING ONLY TO NON-ADULT POPULATIONS WERE DELETED
IN ADDITION, ARTICLES FROM JOURNALS WITH “PEDIATRIC(S)” OR “PAEDIATRIC(S)” IN THE JOURNAL NAME WERE DELETED

APPENDIX B. PEER REVIEWER COMMENTS AND RESPONSES

Comment	Response
Consider this study: J Urology 2019;201:715-720. Sathianathen et al. Robotic assisted radical cystectomy vs open radical cystectomy: Systematic Review and Meta-analysis	Thank you for pointing this out. This study analyzed the same 5 RCTs that have been included also in our report and, therefore, its results and conclusions are consistent with ours (with RARC presenting a decreased need for perioperative blood transfusion, but a longer operative time; there was no difference in disease progression, major complications or QOL).
Why did the authors choose 2010 as a start date? Understanding that the robotic platforms were introduced in 2005, and recognizing that the early literature from this period through 2010 is most likely low quality and high risk of bias, an explanation should be given for the date selection.	We selected 1/1/2010 search start date was chosen based on input from our TEP. After 2010 robotic-assisted procedures became more common and the studies published earlier often reflected learning curves. Thus evidence from studies published from prior to the year 2010 were determined by our TEP to be insufficiently relevant to modern practice. We have added this to the methods section.
The evidence likely also derives mostly from academic centers and centers of excellence and it is unclear if the mostly short-term results from these included studies would be generalizable to a broader population of urologic surgeons and VA settings.	The expense of the robotic platforms has limited broad uptake in community hospitals, and the bulk of the literature represents academic centers. However, as new robotic companies are emerging, community and VA hospitals may incorporate more robots. The training required to use the robot is structured and extensive, as such it is likely that non-academic surgeons will perform as a high quality level and results from our study will apply well. The contention is that centers with experience with the robotic platform can perform cystectomy and partial nephrectomy without compromising perioperative outcomes as well as oncologic outcomes. We attempted to ensure a high level of reliability between data by utilizing literature with large volume as well as recent publications such that it would not necessarily be generalizable to all urologic surgeons but potentially those who have overcome their learning curve and have adequate volume in their practice. Furthermore, a fair number of VA centers are high volume robotic centers currently. Our local VA is actually getting a second robot because of demand. We have a paragraph (page 26) that addresses the possible lack of generalizability of our findings to VA patients (page 36).
Line 20, this is a fragment: “over 125,000 procedures in 2017.”	Thank you for pointing this out, this has been corrected.
Line 43, “On 40 patients have been enrolled in RCTs with 5 year follow-up for either of these two procedures.” Should be “Only”.	Thank you for pointing this out, this has been corrected.
Line 48/49: “Robotic-assisted surgery for cystectomy and partial nephrectomy has a few documented short benefits” should be “short-term benefits”.	Thank you for pointing this out, this has been corrected.

Line 11 of the Evidence Report should be, "Urologic surgery was one of the first surgical disciplines to adopt robotic surgery".	Thank you for pointing this out, this has been corrected.
Line 12 of Key Question 1a should have a semi-colon: "Five studies were randomized trials; of note, two publications were from the same study, but data were abstracted from both, and the remaining studies were observational."	Thank you for pointing this out, this has been corrected.
Line 16 page 21 has an excess comma: "Additionally, several studies commented on the fact that a significant number of patients who were approached for enrollment, chose…" the comma before chose shouldn't be there.	Thank you for pointing this out, this has been corrected.
This is an excellent and thorough review reviewing the literature evaluating the outcomes and cost effectiveness of minimally invasive techniques for radical cystectomy and partial nephrectomy. The authors have provided a comprehensive analysis of the published literature. The overall conclusions trending towards less blood loss for both RARC and RPN are well founded and generally accepted in the urologic literature. However, in more contemporary series, there is also a trend towards lower LOS favoring RARC. this is not reflected in the current review , largely because of the inclusion of1 observational study from Korea (Kim et al, J Endo 2016;30:783-791) which had a very high length of stay for both ORC (22 days) as well as RARC (28 days) which far exceeds what most US centers experience. Most of the RCTs of robotic vs open cystectomy show avg LOS in the 7-10 day range so the Korean study does not represent current practice. Whether this is because of not using an ERAS regimen or other factors relating to hospital practices in Korea cannot be ascertained.	We agree with the reviewer's assessment that the study by Kim and colleagues is an outlier. However, the remaining studies show no statistically significant differences between approaches, so that we are unable to reach a conclusion that LOS is shorter with robot-assisted surgery.
Figures: it would be helpful to define abbreviations shown in the graphs also in the figure legends, not just the body of the manuscript. Also, including the numbers of patients in each study should be shown to give the data better context	Thank you for pointing this out, this has been corrected.
Figure 3: Although the LOS is shown for the Kim study, the LOS data is not included in the summary for this study (Appendix G p 56)	Thank you for pointing this out, this has been corrected.
The cost effectiveness data for cystectomy from the second paper from Europe (Ref #3)	This is a valid consideration. However, a strength of cost-effectiveness analyses is that the relative difference

may not be directly comparable to costs in the US.	within each study is reported. As such, we believe the finding of relative differences for this study are relevant as well to non-European based work.
Outcomes for RARC should be stratified according to whether the urinary diversion is done intracorporeally vs extracorporeally. Most of the RCTs do not make this distinction since the data is relatively sparse, however as more surgeons are performing intracorporeal diversion, it might be expected to change postoperative outcomes (? less ileus,) and potentially LOS and cost. The authors should include this as a possibility to consider even though the existing literature does not.	All urinary diversions included in the RCTs were performed extracorporeally, which was standard of care when these trials were conceived. Moreover, also most of our included observational studies exclusively analyzed RARC with an extracorporeal urinary diversion, and the remaining observational studies didn't stratify their results by an extra- or intra-corporeal technique. At present, data on oncological outcomes of RARC performed with an intracorporeal urinary diversion are limited. Having said that, RARC is increasingly performed intracorporeally, and we agree that future trials/studies should take this into consideration. We have added this comment to our limitations paragraph in the Discussion.
Key question 2A, p26. Last sentence comparing lap to robotic OR times for partial nephrectomy may be becoming moot since most MIS partial nephrectomies are now being done robotically.	Yes, we agree that the majority of partial nephrectomy cases are being performed robotically. However, our TEP believed it was still important to provide the evidence for open versus robotic and laparoscopic versus robotic, especially with the currently climate of robotic surgery oncology outcomes being questioned for other cancer types such as gynecologic surgery.
P 36 under "Heterogeneity". The statement regarding "clamping the arterial supply of the kidney vs inability to do so for the bladder " should be deleted or modified since it is not relevant. There is no organ preservation attempted when performing RC .	Thank you. This was corrected.
One final point that is rarely discussed by the robotic surgeons is the inability to provide cold ischemia during MIS partial nephrectomy vs open partial nephrectomy. This may favor the open procedure when looking at long term functional outcomes.	Thank you for your comment. This important point addressing the difference in technique has been added to the Summary.

Of note, some minor improvements were made to language and presentation throughout the report. None of these changes were substantive.

As part of the revision process, we performed an update search, which resulted in 4 new included observational studies, 2 about cystectomy and 2 about partial nephrectomy. The inclusion of these new studies did not change any of the conclusions from the draft report.

APPENDIX C. COCHRANE RISK OF BIAS TOOL

The Cochrane Collaboration's Tool for Assessing Risk of Bias*

Domain	Support for judgement	Review authors' judgement
Selection bias.		
Random sequence generation.	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.	Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence.
Allocation concealment.	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment.	Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment.
Performance bias.		
Blinding of participants and personnel *Assessments should be made for each main outcome (or class of outcomes).*	Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Performance bias due to knowledge of the allocated interventions by participants and personnel during the study.
Detection bias.		
Blinding of outcome assessment *Assessments should be made for each main outcome (or class of outcomes).*	Describe all measures used, if any, to blind outcome assessors from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Detection bias due to knowledge of the allocated interventions by outcome assessors.
Attrition bias.		
Incomplete outcome data *Assessments should be made for each main outcome (or class of outcomes).*	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomized participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors.	Attrition bias due to amount, nature or handling of incomplete outcome data.
Reporting bias.		
Selective reporting.	State how the possibility of selective outcome reporting was examined by the review authors, and what was found.	Reporting bias due to selective outcome reporting.
Other bias.		
Other sources of bias.	State any important concerns about bias not addressed in the other domains in the tool. If particular questions/entries were pre-specified in the review's protocol, responses should be provided for each question/entry.	Bias due to problems not covered elsewhere in the table.

* http://handbook.cochrane.org/ in Table 8.5.a

APPENDIX D. RISK OF BIAS IN NON-RANDOMISED STUDIES – OF INTERVENTIONS (ROBINS-I)

Bias domains included in ROBINS-I[7]

Pre-intervention	Risk of bias assessment is mainly distinct from assessments of randomised trials
Bias due to confounding	Baseline confounding occurs when one or more prognostic variables (factors that predict the outcome of interest) also predicts the intervention received at baseline ROBINS-I can also address time-varying confounding, which occurs when individuals switch between the interventions being compared and when post-baseline prognostic factors affect the intervention received after baseline
Bias in selection of participants into the study	When exclusion of some eligible participants, or the initial follow-up time of some participants, or some outcome events is related to both intervention and outcome, there will be an association between interventions and outcome even if the effects of the interventions are identical This form of selection bias is distinct from confounding—A specific example is bias due to the inclusion of prevalent users, rather than new users, of an intervention
At intervention	Risk of bias assessment is mainly distinct from assessments of randomised trials
Bias in classification of interventions	Bias introduced by either differential or non-differential misclassification of intervention status Non-differential misclassification is unrelated to the outcome and will usually bias the estimated effect of intervention towards the null Differential misclassification occurs when misclassification of intervention status is related to the outcome or the risk of the outcome, and is likely to lead to bias
Post-intervention	Risk of bias assessment has substantial overlap with assessments of randomised trials
Bias due to deviations from intended interventions	Bias that arises when there are systematic differences between experimental intervention and comparator groups in the care provided, which represent a deviation from the intended intervention(s) Assessment of bias in this domain will depend on the type of effect of interest (either the effect of assignment to intervention or the effect of starting and adhering to intervention).
Bias due to missing data	Bias that arises when later follow-up is missing for individuals initially included and followed (such as differential loss to follow-up that is affected by prognostic factors); bias due to exclusion of individuals with missing information about intervention status or other variables such as confounders
Bias in measurement of outcomes	Bias introduced by either differential or non-differential errors in measurement of outcome data. Such bias can arise when outcome assessors are aware of intervention status, if different methods are used to assess outcomes in different intervention groups, or if measurement errors are related to intervention status or effects
Bias in selection of the reported result	Selective reporting of results in a way that depends on the findings and prevents the estimate from being included in a meta-analysis (or other synthesis)

APPENDIX E. QUALITY ASSESSMENT FOR INCLUDED RCT STUDIES

Author, year	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other sources of bias
Parekh, 2018[14]	™	~	~	~ *	™	™	™
Bochner, 2018[10]	™	™	~	~ *	™	™	™
Khan, 2016[11]	™	™	~	~ *	™	™	™
Messer, 2014[12]	™	~	~	~ *	™	™	~ QOL
Nix, 2010[13]	~	~	~	~ *	™	™	™

™ = low risk of bias ~ = risk of bias ½ = unknown

* low risk of bias for primary outcomes (all-cause mortality and amputation-free survival, but high risk of bias for secondary outcome

APPENDIX F. QUALITY ASSESSMENT FOR INCLUDED OBSERVATIONAL STUDIES

CYSTECTOMY*

	Confounding	Selection bias	Bias in measurement classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result
Tan 2019[23]	Moderate: propensity matched Severe: sig differences in gender, urinary diversion, disease characteristics	Low: consecutive series, all pts analyzed	Low	Low	Low	Low	Low
Ashrafi 2018[24]	Severe: not propensity matched, adjusted for demographics	Low: consecutive series	Low	Low	Low	Low	Low
Niegisch 2018[39]	Serious: small sample size, no propensity/ multivariate Moderate: only 2 year f/u	Low Stage matching	Low	Low	Moderate: pts excluded for short f/u		Low
Simone 2018[21]	Moderate: propensity matching Low: time	Low	Low	Low	Low	Low: short-term (30d) outcomes Low: long-term (4yr) outcomes Moderate: efficacy	Low
Hanna 2017[20]	Severe: patients Low: time	Moderate	Moderate	Low	Moderate	Low: short-term (30d) outcomes Moderate: long-term (2yr) outcomes Low: efficacy	Moderate

	Confounding	Selection bias	Bias in measurement classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result
Gandaglia 2016[16]	Moderate: patients (neoadj) Low: time	Moderate: difference in stage	Low	Low	Moderate	Low: short-term outcomes Low: long-term (5yr) outcomes Low: Efficacy	Low
Hu 2016[17]	Serious: patients (propensity matching) Low: time	Moderate	Moderate	Low	Low: outcomes No info: efficacy	Low: short-term outcomes Low: long-term (5yr) outcomes Serious: efficacy	Moderate
Cusano 2016[15]	Serious: patients Low: time	Serious	Low	Low	Low	Low: short-term outcomes Serious: long-term (<<2yr) outcomes Moderate: efficacy (only PSM)	Low
Kim 2016[18]	Moderate: patients age Low: time	Low	Low	Low	Low	Low: short-term outcomes Low: long-term (4yr) outcomes Low: efficacy	Low
Tan 2016[40]	Moderate: different pt populations; propensity matching Severe: time (f/u for robot short)	Moderate: learning curve; robot instituted later	Low	Low	Low	Severe: Short-term outcomes, only margins Moderate: long-term outcomes (only 2 yr) Moderate: Efficacy, margins and LNs	Low
Nguyen 2015[19]	Moderate: patient age Low: time	Moderate: difference in clinical stage	Low	Low	Low	Low: short-term outcomes Moderate: long-term (2yr) outcomes Low: efficacy	Low

*All 9 observational studies for cystectomy were most concerning for confounding due to the retrospective nature of the studies, and low in bias due to intervention deviation. Cusano et al and Nieglsch had a risk of serious confounding due to lack of propensity matching or multivariate analysis. Nieglsch also had small sample size for both arms. Hanna et al and Hu et al used large administrative datasets from NCDB (National Cancer Data Base) [Hanna] and SEER (Surveillance, Epidemiology, and End Results Program) respectively, making the studies prone to lack of standardization of surgical techniques, entering errors, misclassification, and missing observation across multiple centers. Thus both studies had seriousness for confounding bias; moderation in selection bias, bias in measurement classification, missing data bias, and reporting bias. Except for these 2 studies (due to adopting large administrative datasets and Niegisch et al due to large amount

of excluding patients with less than 1 year follow-up), missing data bias was low among all the studies. Reporting bias was deemed to be low among all studies except Hanna et al and Hu et al as mentioned above. Cusano et al has serious selection bias due to lack of patient exclusion criteria. Gandaglia et al, Nguyen et al, and Tan et al have moderate selection bias due to prominent difference in clinical stages between arms as well as default operation of choice based on timeline of the study. Tan et al and Nieglsch et al had serious bias in short-term outcome measurement given only having PSM (positive surgical margin) results and lack of perioperative and short-term outcome results. All have moderate to serious long-term outcome bias due to short follow-up time (equal or less than 2 years), except Simone et al, Gandaglia et al, Hu et al, and Kim et al. Efficacy outcome is measured by PSM, amount of removed lymph node as well as perioperative results. The bias in efficacy outcome in Hu et al is considered to be serious as only the percentage of more than 10 lymph node removed was reported.

PARTIAL NEPHRECTOMY

	Confounding	Selection bias	Bias in measurement classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result
Kizilay 2019[33]	Moderate: propensity matched Severe: sig differences in tumor laterality + location (RAPN - complex tumors); intraop technique and learning curve not accounted for	Severe: not consecutive series… unclear how many pts were excluded	Low	Low	Low	Low	Low
Yu 2019[34]	Moderate: propensity matched Severe: sig age, BMI, baseline eGFR, and tumor volume differences	Moderate: many pts excluded	Low	Low: conversions excluded	Moderate: missing data excluded (not clear how many)	Low	Low
Chang 2018[28]	Moderate	Serious	Low	Low	Low	Low	Low
Gu 2018[29]	Moderate	Serious	Low	Low	Low	Low	Low
Oh 2016[30]	Moderate	Serious	Low	Moderate	Low	Low	Moderate
Peyronnet 2016[31]	Serious	Low	Low	Moderate	Low	Low	Moderate
Wang 2015[32]	Serious	Serious	Low	Moderate	Low	Low	Low

APPENDIX G. EVIDENCE TABLES

CYSTECTOMY RCT

Author Year Population **#Institutions/ Surgeons**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, %			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term outcomes** Clavio-D ≥ 3, % (30d) 30d complication rate, % Major complication rate, % PSM, % LOS, mean days			**Long-term outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, % Quality of Life (QoL)			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Bochner 2018[10] Bochner 2014[9] 2010-2013, Memorial Sloan Kettering Cancer Center 1 institution 7 Surgeons (3 RACC & 4 ORC)		Size 60 Age 66 [60-71] Male 85% BMI ASA≥3 71.7%	Size 58 Age 65 [58-69] Male 72.4% BMI ASA≥3 79.3%		NMI Cl Stage ≥ T2a 48.3% Pa Stage ≥ T2 41.3% NACT	NMI Cl Stage ≥ T2a 56.9% Pa Stage ≥ T2 44.9% NACT		OR 456 (82) EBL Avg Lym -std 20 [13-25] Clavio-D 22% Urinary compl 10% PSM 3.6% LOS 8 (3)	OR 329 (77) EBL Avg Lym- std 18 [13-23] Clavio-D 21% Urinary compl 9% PSM 4.8% LOS 8 (5)		LR 28.3% TR 33.3% CSS- 5yr* 75%-80% OS- 5yr* 65-70% *Extrapol-ated from the graphs	LR 8.6% TR 43.1% CSS-5yr* 75%-80% OS- 5yr* 65-70% *Extrapolated from the graphs	No difference in recurrence or cancer specific survival or overall survival. Increase in metastatic sites for ORC. Greater local and abdominal sites in RARC.

Author Year Population **#Institutions/ Surgeons**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, %			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term outcomes** Clavio-D ≥ 3, % (30d) 30d complication rate, % Major complication rate, % PSM, % LOS, mean days			**Long-term outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, % Quality of Life (QoL)			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Parekh 2018[14] RAZOR 2011-2014, 15 medical centres in USA 15 institutions		Size 150 Age 70 [43-90] Male 84% BMI 27.8 [25-30.8] ASA ≥ 3	Size 152 Age 67 [37-85] Male 84% BMI 28.2 [24.9-31.7] ASA ≥ 3		NMI Cl Stage ≥ T2a 13.3% Pa Stage ≥ T2 56% NACT 27%	NMI Cl Stage ≥ T2a 13.2% Pa Stage ≥ T2 53.9% NACT 36%		OR 428 [322-509] EBL 300 [200-500] Avg Lym 23.3 (12.5) Clavio-D 90d 22% 30d compl 67% Urinary compl 35% PSM 6% LOS 6 [5-10]	OR 361 [281-450] EBL 700 [200-1000] Avg Lym 25.7 (14.5) Clavio-D 90d 22% 30d compl 69% Urinary compl 26% PSM 5% LOS 7 [6-10]		LR 4% TR 26% CFS- 2yr 72.3% Cancer Mortality 19% QoL (FACT-VCI + Short form 8) 126 [120.4-131.6]	LR 3% TR 27% CFS- 2yr 71.6% Cancer Mortality 21% QoL (FACT-VCI + Short form 8) 127.5 [121.7-133.3]	No difference in 2 year progression free survival and QoL outcomes.

Author Year Population **#Institutions/ Surgeons**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, %			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term outcomes** Clavio-D ≥ 3, % (30d) 30d complication rate, % Major complication rate, % PSM, % LOS, mean days			**Long-term outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, % Quality of Life (QoL)			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Khan 2016[11] Omar 2018[22] CORAL 2009-2012 Guy's Hospital London UK 1 institution *90 days	Size 19 Age 68.6 (9.9) Male 79% BMI 26.2 (3.6) ASA ≥ 3 16%	Size 20 Age 68.6 (6.8) Male 85% BMI 27.5 (4.2) ASA ≥ 3 5%	Size 20 Age 66.6 (8.8) Male 90% BMI 27.4 (3.9) ASA ≥ 3 5%	NMI 26.3% Cl Stage ≥ T2a 73.7% Pa Stage ≥ T2 57.9% NACT 21%	NMI 40.0% Cl Stage ≥ T2a 60.0% Pa Stage ≥ T2 45.0% NACT 10%	NMI 40.0% Cl Stage ≥ T2a 60.0% Pa Stage ≥ T2 30.0% NACT 15%	OR 301 (51) EBL 460 (485) Avg Lym 15.5 Clavio-D 5.3% 30d compl 26% Major compl* 11% PSM 5% LOS 9.7 (3.6)	OR 389 (98) EBL 585 (618) Avg Lym 16.3 Clavio-D 25% 30d compl 55% Major compl* 35% Urinary compl 15% PSM 15% LOS 11.9 (6.2)	OR 293 (66) EBL 808 (329) Avg Lym 18.8 Clavio-D 20% 30d compl 70% Major compl* 20% Urinary compl 15% PSM 10% LOS 14.4 (5.9)	TR-12 mo 17% CSS- 5yr 69% CFS- 5yr 71% OS- 5yr 61% QoL (FACT Bl) 127.4 (13.5)	TR-12 mo 26% CSS- 5yr 70% CFS- 5yr 60% OS- 5yr 66% QoL (FACT Bl) 122.3 (17.1)	TR- 12 mo 11% CSS- 5yr 64% CFS- 5yr 53% OS- 5yr 55% QoL (FACT Bl) 124.9 (12.7)	ORC has significant higher 30d complication rate than LRC. No difference in 90d clavien graded compilation rate. OT time is longer in RARC. No significant difference s in QoL measures.

Author Year Population **#Institutions/ Surgeons**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, %			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term outcomes** Clavio-D ≥ 3, % (30d) 30d complication rate, % Major complication rate, % PSM, % LOS, mean days			**Long-term outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, % Quality of Life (QoL)			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Parekh 2013[41] Messer 2014[12] 2009-2011, University of Texas Health Sciences Center, San Antonio 1 institution		Size 20 Age 69.5 [62.3-74] Male 90% BMI 27.6 [24.2-29.9] ASA≥3 85%	Size 20 Age 64.5 [59.8-72.3] Male 80% BMI 28.3 [26.1-32.3] ASA ≥ 3 80%		NMI Cl Stage ≥ T2a Pa Stage ≥ T2 65% NACT 30%	NMI Cl Stage ≥ T2a Pa Stage ≥ T2 40% NACT 35%		OR 300 [240-366] EBL 400 [300-762.5] Avg Lym 11.8 [8.8-21.5] Major compl 25% PSM 5% LOS 6 [5-9.5]	OR 285.5 [240-321.3] EBL 800 [400- 1125] Avg Lym 23[15-28] Major compl 25% PSM 5% LOS 6 [6-9.3]		FACT-VCI* (baseline to 3mo) 119-> 116 *Functional assessment of cancer therapy – Vanderbilt cystectomy index	FACT-VCI* (baseline to 3mo) 135->129	No significant difference in oncologic efficacy. RARC associated with decreased EBL and LOS. NO significant difference in Health related quality of life.

Author Year Population **#Institutions/ Surgeons**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, %			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term outcomes** Clavio-D ≥ 3, % (30d) 30d complication rate, % Major complication rate, % PSM, % LOS, mean days			**Long-term outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, % Quality of Life (QoL)			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Nix 2010[13] Smith 2012[42] 2008-2009, University of North Carolina 1 Institution		Size 21 Age 67.4 [33-81] Male 66.6% BMI 27.5 ASA Avg=2.71	Size 20 Age 69.2 [51-80] Male 85% BMI 28.4 ASA Avg=2.70		NMI Cl Stage ≥ T2a 71.4% Pa Stage ≥ T2 81% NACT	NMI Cl Stage ≥ T2a 75% Pa Stage ≥ T2 65% NACT		OR 4.2 EBL 258 Avg Lym 19 [12-30] Clavio-D 30d compl 33% Urinary compl 14% PSM 0% LOS 5.1	OR 3.52 EBL 575 Avg Lym 18 [8-30] Clavio-D 30d compl 50% Urinary compl 15% PSM 0% LOS 6		TR- 3yr 14% CSS- 3yr 85% OS- 3yr 81%	TR- 3yr 35% CSS- 3yr 68% OS- 3yr 65%	3 yr f/u eval shows no difference ding overall survival and disease specific survival, recurrence, or complications or LOS. RACC is favorable in several periop parameter (EBL, inpt narcotic requirements)

CYSTECTOMY OBSERVATIONAL STUDIES

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, % CCI ≥2,%			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative Outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term Outcomes** Clavio-D >=3, % 30d complication rate, % Major complication rate, % PSM, % LOS, mean days Readmissions, mean			**Long-term Outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Tan et al[i] 2019[23] Open vs robot 43- and 35.5-mo f/u					Pa Stage ≥ T2 (50) NACT (38.9)	Pa Stage ≥ T2 (47.6) NACT (14.3)		Avg Lym 28 PSM 0 (0)	Avg Lym 34 PSM 0 (0)		CFS 37.5 mo[ii] OS 43.0 mo[iii]	CFS 21.4 mo OS 35.5 mo	Nonsignificant difference in NACT (p=0.14) average lymph node yield (p=0.256), and pathological stage (p=0.856) No significant difference in CFS (p=0.093) and OS (p=0.14)
Ashrafi, et al. 2018[24] Open vs robot 12 mo f/u		Size 238 Age 70.1 (9.9) Male 203 (85.7) BMI 27.6 (5.5) ASA≥2 189 (79.8)	Size 598 Age 69.7 (10.7) Male 475 (79.4) BMI 27.3 (4.9) ASA≥2 470 (73.6)		Pa Stage ≥ T2 146 (61.6) NACT 56 (23.6)	Pa Stage ≥ T2 289 (48.3) NACT 173 (28.9)		PSM 3 (1.3)	PSM 7 (1.2)		CFS No differences in Kaplan-Meier plots	CFS No differences in Kaplan-Meier plots	No significant difference recurrences (p=0.6) or cancer free survival (p=0.39)

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, % CCI ≥2,%			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative Outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term Outcomes** Clavio-D >=3, % 30d complication rate, % Major complication rate, % PSM, % LOS, mean days Readmissions, mean			**Long-term Outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Simone 2018[21] Robot vs open 1 institution; 3 surgeons yes		Size 64 Age 62.5 (7.4) Male 78.1% BMI 26.1 (3.25) ASA 12.5%	Size 299 Age 63 (8.6) Male 86.6% BMI 26.8 (3.47) ASA 20.7%		NMI 4.7% Cl Stage ≥ T2a 53.1% Pa Stage ≥ T2 68.8% NACT 25%	NMI 8.4% Cl Stage ≥ T2a 71.6% Pa Stage ≥ T2 71.6% NACT 4.7%		OR EBL Clavio-D 6.3% 30d compl 91.3% Major compl 6.3% PSM 0% LOS	OR EBL Clavio-D 0.33% 30d compl 42.2% Major compl 0.33% PSM 0.33% LOS		Local CSS- 4yr 86.4% OS- 4yr 82.1%	Local CSS- 4yr 85.3% OS- 4yr 79.6%	ORC higher rate perioperative complication (91.3% vs 42.2%) Both have comparable disease-free survival, cancer-specific survival, and overall survival rates.
Hanna 2017[20] Robot vs open >1500 institutions; yes		Size 2048 Age 69 [62-76] Male 78.8% BMI ASA CCI 8.4%	Size 7513 Age 70 [62-77] Male 74.1% BMI ASA CCI 7.0%		NMI 0% Cl Stage ≥ T2a 46.8% Pa Stage ≥ T2 68.8% NACT 0%	NMI 0% Cl Stage ≥ T2a 50.1% Pa Stage ≥ T2 46.8% NACT 0%		OR EBL Avg Lym 17 [10-25] Clavio-D 30d compl PSM 9.3% LOS 7 [6-10] Readm 10.2%	OR EBL Avg Lym 12 [7-20] Clavio-D 30d compl PSM 10.7% LOS 8 [6-11] Readm 10.2%		OS- 2yr 70.2%	OS- 2yr 62.5%	Intraop outcome wise, equivalent PSM, higher median LN count of dissection, postop wise, RARC shorter LOS, lower 30/90 day postop mortality for RARC (1.4%/ 4.8% vs 2.8%/ 6.7%. Better overall 2-yr survival in RARC

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, % CCI ≥2,%			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative Outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term Outcomes** Clavio-D >=3, % 30d complication rate, % Major complication rate, % PSM, % LOS, mean days Readmissions, mean			**Long-term Outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Cusano 2016[15] Robot vs open 1 Institution 6 surgeons No *patients during a 10 year period with median f/u 1.38 and 1.40 yr for ORC and RARC respectively		Size 121 Age 65.9 (10.4) Male 78.5% BMI 28.2(5) ASA 3 [10-25] 50% CCI 4 [3-5]	Size 92 Age 67.8 (10.4) Male 79.3% BMI 28.4 (5.2) ASA 3 [10-25] 50% CCI 4 [3-5]		NMI 69.2% Cl Stage ≥ T2a 68.6% Pa Stage ≥ T2 58.7% NACT 31.4%	NMI 72.5% Cl Stage ≥ T2a 71.7% Pa Stage ≥ T2 68.7% NACT 22.8%		OR 508 [436-589] EBL 450 [300-725] Avg Lym 18 [11-24] Clavio-D Major compl 18.2% PSM 8.3% LOS Readm	OR 403 [359-467] EBL 600 [450-1100] Avg Lym 11.5 [7-19] Clavio-D Major compl 20.7% PSM 5.6% LOS Readm		LR* 22.3% CSS CFS Overall Mortality*: 24%	LR* 34.8% CSS CFS Overall Mortality*: 37%	ORC with shorter operative time, greater blood loss and transfusion rate. No difference in LOS. Greater number of lymph removed in RARC. ORC associated with higher mortality rate. No difference in disease free survival.

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, % CCI ≥2,%			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative Outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term Outcomes** Clavio-D >=3, % 30d complication rate, % Major complication rate, % PSM, % LOS, mean days Readmissions, mean			**Long-term Outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Gandaglia 2016[16] Robot vs open 2 institution; 3 surgeons No		Size 138 Age 70 [60.7-77] Male 83.5% BMI 26.1 [22.9-28.6] ASA 39.1% CCI	Size 230 Age 70.9 [63.1-77.5] Male 83.5% BMI 26 [23.5-29] ASA 38.7% CCI		NMI Cl Stage ≥ T2a 64.5% Pa Stage ≥ T2 58.7% NACT 19.6%	NMI Cl Stage ≥ T2a 57.3% Pa Stage ≥ T2 60.9% NACT 0%		OR 330 [260-370] EBL 300 [200-430] Avg Lym 12 [8-17] Clavio-D 15.9% 30d compl PSM 8.7% LOS 13 [11-17] Readm 10.1%	OR 185 [165-222] EBL 300 [200-500] Avg Lym 13 [9-17] Clavio-D 20.4% 30d compl PSM 13.5% LOS 20 [16-24] Readm 15.7%		CSS- 5yr 73.5% CFS- 5yr 54.2%	CSS- 5yr 61.9% CFS- 5yr 57.1%	OR associated with shorter operative time, RARC with lower blood loss and shorter LOS. No differences in major complication and positive margin. Similar oncologic control.

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, % CCI ≥2,%			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative Outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term Outcomes** Clavio-D >=3, % 30d complication rate, % Major complication rate, % PSM, % LOS, mean days Readmissions, mean			**Long-term Outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Hu 2016[17] Robot vs open N/A Yes *Estimated based on the given range #RARC slightly better		Size 439 Age 75* Male 86.1% BMI ASA CCI	Size 7308 Age 75* Male 80.9% BMI ASA CCI		NMI 0% Cl Stage ≥ T2a Pa Stage ≥ T2 64.0% NACT 19.4%	NMI 0% Cl Stage ≥ T2a Pa Stage ≥ T2 70.7% NACT 13.0%		OR EBL Avg Lym ≥ 10 41.5% Clavio-D Major compl 8.0% PSM Readm -30d 28.2%	OR EBL Avg Lym ≥ 10 31.1% Clavio-D Major compl 9.8% PSM Readm -30d 26.1%		Hazard Ratio of 3 yr OS =0.88# Hazard Ratio of 2 yr CSS = 0.91		RARC associated with greater lymph node yield, shorter LOC, increased home healthcare utilization. Similar overall survival, cancer specific survival.

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, % CCI ≥2,%			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative Outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term Outcomes** Clavio-D >=3, % 30d complication rate, % Major complication rate, % PSM, % LOS, mean days Readmissions, mean			**Long-term Outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Kim 2016[18] Robot vs open vs lap 1 Institution No	Size 22 Age 65 [62.8-74] Male 90% BMI 23 [20.9-26.1] ASA 13.6% CCI	Size 58 Age 61.5 [54.8-72] Male 93.1% BMI 22.8 [20.8-25.5] ASA 6.9% CCI	Size 150 Age 68 [60-73] Male 82.0% BMI 23.9 [21.9-26.3] ASA 7.3% CCI	NMI 0 Cl Stage ≥ T3a 54.5% Pa Stage ≥ T2 100% NACT 4.5%	NMI 0 Cl Stage ≥ T3a 41.4% Pa Stage ≥ T2 100% NACT 1.7%	NMI 0 Cl Stage ≥ T3a 52.0% Pa Stage ≥ T2 100% NACT 6.0%	OR 524 [490.8-593.8] EBL 400 [300-700] Avg Lym 19.5 [14.8-27.3] Clavio-D Major compl PSM 0 LOS 12 [10-15] Readm	OR 501.5 [440.8-604.0] EBL 500 [368.8-700] Avg Lym 18.0 [14-25.3] Clavio-D Major compl PSM 3.4% LOS 28 [18-34.3] Readm	OR 508 [436-589] EBL 840 [557.5-1500] Avg Lym 15 [10-20] Clavio-D Major compl PSM 4.0% LOS 22 [17-32] Readm	Available on graphs without individual values (4 yr CFS, CSS, OS)	Available on graphs without individual values (4 yr CFS, CSS, OS)	Available on graphs without individual values (4 yr CFS, CSS, OS)	Operative time shorter for ORC, surgical blood loss and transfusion rate lower in RARC. RARC has a greater number of lymph node removed, lower disease recurrence. ORC associated with higher overall mortality. No difference in disease-free survival between groups.

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Sample Size Age, mean yr Male, % BMI mean ASA ≥3, % CCI ≥2,%			**Tumor factors** Non-Muscle invasive/ NMI, % Clinical Stage ≥ T2a, % Pathologic Stage ≥ T2, % Neoadjuvant chemo/ NACT, %			**Intraoperative Outcomes** OR, time, min EBL, mL Transfusions, % Avg Lymph Node Count **Short-term Outcomes** Clavio-D >=3, % 30d complication rate, % Major complication rate, % PSM, % LOS, mean days Readmissions, mean			**Long-term Outcomes** Local recurrences/ LR, % Total recurrences/ TR, % Cancer-specific Survival, % Cancer-free Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Nguyen 2015[19] Robot vs open 1 Institution No		Size 263 Age 72 [65-79] Male 78.7% BMI 25 [23-28] ASA 52% CCI	Size 120 Age 69 [63-75] Male 70.8% BMI 24 [24-28] ASA 54% CCI		NMI Cl Stage ≥ T2a 64.6% Pa Stage ≥ T2 49% NACT 24%	NMI Cl Stage ≥ T2a 64.2% Pa Stage ≥ T2 61% NACT 23%		OR EBL Avg Lym 21 [13-28] Clavio-D Major compl PSM 6% LOS Readm	OR EBL Avg Lym 20 [11-27] Clavio-D Major compl PSM 13% LOS Readm		LR 18%% TR 47% Available on graphs without individual values (4 yr CFS)	LR 23% TR 59% Available on graphs without individual values (4 yr CFS)	No significant difference in number of local or distant recurrences of 2 yr. Recurrence at extrapelvic lymph node locations and peritoneal carcinomatosis are more freq in RARC

[a]Median [IQR] [b]Mean (SD)

i Unclear what the sample size was after propensity score matching (18 and 21 before matching for iRARC and ORC respectively)

ii Recurrence free survival reported in months

iii Overall survival reported in months

Partial Nephrectomy Observational Studies

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Age, mean yr (SD) Male, % BMI mean (SD) Solitary kidney, % Preop GFR, median [IQR] Preop Renal Score, mean (SD)			**Tumor factors** Tumor size, median mm, [IQR] Clear cell, % Benign, % Stage ≥T2a, % Laterality, right %			**Intraoperative Outcomes** WIT, min (SD) OR, time, min (SD) EBL, mL (SD) Transfusions, % **Short-term Outcomes** Clavio-D >=3, % GU complications, % PSM, % LOS, mean days (SD) Readmissions, mean (SD)			**Long-term Outcomes** Change GFR (6 mo), mean (SD) Change GFR (1 yr), mean (SD Local recurrences, % Total recurrences, % Cancer-specific Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
Kizilay, et al 2019 [33] Lap vs robot 1 institution yes	Age 54.6 (12.4) Male 37 (52.2) BMI 23.8 (3.1) Preop GFR 84.9 (21.4) *Mean + SD	Age 52.9 (11.8) Male 40 (56.4) BMI 24.5 (4.2) Preop GFR 82.6 (18.1)		Tumor size 27.9 (11.8) * Mean+ SD Laterality 39 (33.9)	Tumor size 24.8 (11.2) Laterality 44 (62.0)		WIT 24.4 (12.1) OR 158 [128-211] Median + range (not IQR) EBL 240 [120-330] Transfusions 4 (5.6) PSM 3 (4.2) LOS 3.5 [2-6] Median + range (not IQR)	WIT 18.8 (10.7) OR 176 [154-251] EBL 210 [100-385] Transfusions 3 (4.2) PSM 2 (2.3) LOS 3.2 [2-5]		GFR 1 yr 12.39 [3.86-24.35] Median + range (not IQR) CSS 61 (85.9) Median + range (not IQR) OS 60 (84.8)	GFR 1 yr 11.38 [4.12-22.88] CSS 64 (90.1) OS 59 (82.6)		No differences in 5-year OS (p=0.561) and CSS (0=0.710) rates WIT shorter in RAPN (p=0.019)
Yu, et al. 2019[34] Open vs robot 1 institution yes		Age 54 [45-63] *Median + IQR) Male 212 (70.0) BMI 24.7 [22.9-26.5]	Age 56 [46-65] Male 204 (67.3) BMI		Tumor size 27 [20-38] Clear cell 184 (60.7) Benign 37 (12.2) Stage≥T2a 2 (0.7)	Tumor size 28 [20-40] Clear cell 186 (61.4) Benign 35 (11.6)		WIT 22 [18-27] *Median + IQR OR 120 [100-180] *Median + IQR	WIT 16 [13-20] OR 130 [110-155] EBL 150 [100-250] Transfusions 3 (1.0)		Total (5.3) *Unclear what the sample size was, only % listed CSS (95.9)	Total (8.5) CSS (92.8)	No significant difference in 5-year recurrence (p=0.059) or CSS (p=0.135) EBL (p<0.001), PSM (p=0.033) were

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Age, mean yr (SD) Male, % BMI mean (SD) Solitary kidney, % Preop GFR, median [IQR] Preop Renal Score, mean (SD)			**Tumor factors** Tumor size, median mm, [IQR] Clear cell, % Benign, % Stage ≥T2a, % Laterality, right %			**Intraoperative Outcomes** WIT, min (SD) OR, time, min (SD) EBL, mL (SD) Transfusions, % **Short-term Outcomes** Clavio-D >=3, % GU complications, % PSM, % LOS, mean days (SD) Readmissions, mean (SD)			**Long-term Outcomes** Change GFR (6 mo), mean (SD) Change GFR (1 yr), mean (SD Local recurrences, % Total recurrences, % Cancer-specific Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
		*Median + IQR Preop GFR 82.3 [71.0-92.3] Preop Renal 8 [6-9] *Median + IQR	24.4 [22.2-26.5] Preop GFR 79.2 [66.1-79.3] Preop Renal 8 [6-9]			Stage ≥ T2a 1 (0.3)		EBL 100 [50-200] *Median + IQR Transfusions 12 (4.0) PSM 1 (0.3)	PSM 7 (2.3)				significantly lower in RAPN
Chang, 2018[28] Lap vs robot vs open 4 institutions; 6 surgeons yes	Age 53.5 (13.3) Male 56.6% BMI 25.2 (5.7) Preop GFR 92 [83-97] Preop Renal 6.2 (1.9)	Age 53.2 (12.3) Male 50.8% BMI 24.6 (2.7) Preop GFR 94 [85-99] Preop Renal 6 (1.8)	Age 53.8 (12.9) Male 54.1% BMI 23.9 (3.1) Preop GFR 92 [84-98] Preop Renal 6.1 (1.8)	Tumor size 27 [19-43] Clear cell 66.4% Benign 11.5% Stage≥T2a 1.6% Laterality 49.2%	Tumor size 28 [22-48] Clear cell 70.5% Benign 9% Stage≥T2a 1.6% Laterality 50.2%	Tumor size 25 [20-45] Clear cell 61.5% Benign 10.7% Stage≥T2a 0.8% Laterality 51.6%	WIT 24.3 (19) OR 241.9 (90) EBL 196.1 (142) Clavio-D 7.3% PSM 4.1% LOS 6.9 (4.3)	WIT 22 (14.6) OR 182.5 (68.6) EBL 167.7 (147) Clavio-D 5.7% PSM 2.5% LOS 5.3 (3.4)	WIT 27.1 (13.2) OR 172.5 (64) EBL 206.4 (135) Clavio-D 7.3% PSM 1.6% LOS 6.1 (3.2)	Local 2.5% CSS 86.9%	Local 1.5% CSS 90.2%	Local 1.6% CSS 88.5%	LPN associated with longer mean OPT (p=0.001) RAPN had a lower mean EBL (p=0.025, LPN; p=0.040, OPN)
Gu 2018[29] Lap vs robot 1 institution; 5 surgeons yes	Age 50 [39-59][a] Male 68.8% BMI 26.1 [22.2-28.4][a]	Age 51 [41-60][a] Male 74% BMI 26.2 [24.2-28.0][a] Solitary 4.2%		Tumor size 48 [43-53] Clear cell 67.7% Benign 6.3%	Tumor size 48 [43-53] Clear cell 79.2% Benign 1.0% Stage≥T2a 1.6%		WIT 25 [19-30][a] OR 128 [105-160][a] EBL 150 [120-200][a] Transfusion	WIT 20 [16-26][a] OR 133 [110-174][a] EBL 100 [50-200][a] Transfusion		GFR, 6 mo 10.3 (10.9) Local Total CSS	GFR, 6 mo 5.1 (9.2) Local Total CSS OS		LPN associated with higher EBL and LOS (p<0.001)

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Age, mean yr (SD) Male, % BMI mean (SD) Solitary kidney, % Preop GFR, median [IQR] Preop Renal Score, mean (SD)			**Tumor factors** Tumor size, median mm, [IQR] Clear cell, % Benign, % Stage ≥T2a, % Laterality, right %			**Intraoperative Outcomes** WIT, min (SD) OR, time, min (SD) EBL, mL (SD) Transfusions, % **Short-term Outcomes** Clavio-D >=3, % GU complications, % PSM, % LOS, mean days (SD) Readmissions, mean (SD)			**Long-term Outcomes** Change GFR (6 mo), mean (SD) Change GFR (1 yr), mean (SD Local recurrences, % Total recurrences, % Cancer-specific Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
	Solitary 4.2% Preop GFR 95.4 (16.1)[b] Preop Renal 8 [7-9][a]	Preop GFR 93.2 (20.2)[b] Preop Renal 8 [7-9][a]		Stage≥T2a 1.6% Laterality 47.9%	Laterality 46.9%		8.3% Clavio-D 2.1% GU 1% PSM 1.0% LOS 7 [5-8][a]	6.3% Clavio-D 4.2% GU 2.1% PSM 1.0% LOS 5 [5-7][a]		OS			
Oh 2016[30] Robot vs open N/A yes		Age 52.9 (12.0) Male 72.2% BMI 24.8 (3.3) Preop GFR 91.4 (56.6)[b]	Age 53.3 (12.9) Male 68.6% BMI 24.6 (3.0) Preop GFR 77.5 (18.6)[b]		Tumor size 22.0 (8.2)[b] Clear cell 76% Laterality 49.2%	Tumor size 22.4 (8.2)[b] Clear cell 75.3% Laterality 50.6%		WIT 20.8 (7.7) OR 137.5 (59.0) EBL 167.2 (236.6) Transfusion 1.6% Clavio-D 2.2% PSM 1.33%	WIT 17.01 (7.69) OR 140.9 (46.2) EBL 214.3 (202.7) Transfusion 3.1% Clavio-D 7.0% PSM 1.67%		GFR, 6 mo GFR, 1y Local Total CSS OS	GFR, 6 mo GFR, 1y Local Total CSS OS	OPN associated with a longer surgical margin width (p=0.016)
Peyronnet 2016[31] Robot vs open N/A no		Age 69.6 (3.4) Male 63.7% BMI 26.6 (0.2) Preop GFR 82.7 (1.1)[b]	Age 57.5 (3.6) Male 64.8% BMI 26.5 (0.2)		Tumor size 32.9 (0.6)[b] Clear cell 61.1% Benign 14.6%	Tumor size 39.9 (0.6)[b] Clear cell 74.8% Benign 4.0%		WIT 15.7 (0.3) OR 153.2 (2.0) EBL 275.1 (13) Transfusion 8.1%	WIT 18.6 (0.4) OR 146.6 (2.3) EBL 359.5 (15.2) Transfusion 12.9%		GFR, 6 mo GFR, 1y Local Total 2.2% CSS	GFR, 6 mo GFR, 1y Local Total 12.7% CSS	OPN had a higher complication rates (p<0.001) and greater EBL (p<0.001) RAPN had a shorter WIT

Author Year Population **#Institutions/ Surgeons** **Propensity matching (yes/no)**	**Patient characteristics, Preop** Age, mean yr (SD) Male, % BMI mean (SD) Solitary kidney, % Preop GFR, median [IQR] Preop Renal Score, mean (SD)			**Tumor factors** Tumor size, median mm, [IQR] Clear cell, % Benign, % Stage ≥T2a, % Laterality, right %			**Intraoperative Outcomes** WIT, min (SD) OR, time, min (SD) EBL, mL (SD) Transfusions, % **Short-term Outcomes** Clavio-D >=3, % GU complications, % PSM, % LOS, mean days (SD) Readmissions, mean (SD)			**Long-term Outcomes** Change GFR (6 mo), mean (SD) Change GFR (1 yr), mean (SD Local recurrences, % Total recurrences, % Cancer-specific Survival, % Overall Survival, %			**Primary Multi-variate Findings**
	Lap	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	**Lap**	**Robot**	**Open**	
		Preop Renal 6.8 (0.1)	Preop GFR 81.2 (1.5)[b] Preop Renal 6.7 (0.1)					Clavio-D 7.8% GU 2.0% PSM 5.2% LOS 4.7 (0.2)	Clavio-D 11% GU 4.3% PSM 6.5% LOS 10.1 (0.2)		97.9% OS	96.3% OS	(p<0.001) and LOS (p<0.001)
Wang 2015[32] Lap vs robot N/A no	Age 63.5 (14.8) Male 65.9% BMI 24.3 (4.2) Preop GFR 85.8 (21.8)[b] Preop Renal 8.1 (1.1)	Age 61.2 (12.6) Male 67.9% BMI 25.2 (5.1) Preop GFR 79.6 (18.3)[b] Preop Renal 8.3 (0.9)		Tumor size 36 (17)[b] Clear cell 73% Benign 14.8%	Tumor size 38 (22)[b] Clear cell 43% Benign 11.1%		WIT 22.3 (8.4) OR 149.6 (43.5) EBL 220.8 (72.9) Transfusion 5.9% Clavio-D 4.4% GU 3.0% PSM 1.5% LOS 8.1 (2.4)	WIT 20.5 (7.6) OR 135.6 (37.8) EBL 196.5 (63.6) Transfusion 7.6% Clavio-D 3.7% GU 1.2% PSM 1.2% LOS 7.6 (1.8)		GFR, 6 mo 8.6 (8.1) Local Total CSS OS	GFR, 6 mo 7.0 (6.4) Local Total CSS OS		LPN associated with a longer OT (p=0.017)

[a]Median [IQR]
[b]Mean (SD)

APPENDIX H. CITATIONS FOR EXCLUDED PUBLICATIONS

Intervention (n=3)

1. Fraisse, G., et al., *Peri-operative and local control outcomes of robot-assisted partial nephrectomy vs percutaneous cryoablation for renal masses: comparison after matching on radiological stage and renal score.* BJU Int, 2018.
2. Tanagho, Y.S., et al., *Renal cryoablation versus robot-assisted partial nephrectomy: Washington University long-term experience.* J Endourol, 2013. **27**(12): p. 1477-86.
3. Weinberg, A.C., et al., *Utilization and perioperative complications of laparoscopic cryoablation vs robotic partial nephrectomy for localized renal tumors.* Int Braz J Urol, 2015. **41**(3): p. 473-85.

Comparison (n=4)

1. Ludwig, W.W., M.A. Gorin, and M.E. Allaf, *Reducing the cost of robotic partial nephrectomy through innovative instrument use.* European Urology, 2015. **67**(3): p. 594-595.
2. Philip, S., P. Hurley, and VSK. Mittal, *Ureteric and Bladder Injuries with Laparoscopic and Robotic Surgery: A Community Teaching Hospital Experience.* Am Surg, 2016. **82**(4): p. E76-7.
3. Pradere, B., et al., *Open partial nephrectomy vs robot-assisted partial nephrectomy for cystic renal masses: Impact of peroperative cystic spillage and oncological results.* European Urology, Supplements, 2018. **17**(2): p. e938-e940.
4. Salkini, M. and A. Lamoshi, *Recurrence patterns of renal cell carcinoma after robotic partial nephrectomy.* Journal of Endourology, 2018. **32**: p. A223.

Procedure (n=3)

1. Gershman, B., et al., *The Association of Robot-assisted Versus Pure Laparoscopic Radical Nephrectomy with Perioperative Outcomes and Hospital Costs.* European Urology Focus, 2018.
2. Soria, F., et al., *Comparative Effectiveness in Perioperative Outcomes of Robotic versus Open Radical Cystectomy: Results from a Multicenter Contemporary Retrospective Cohort Study.* European Urology Focus, 2018.
3. Tamhankar, A.S., et al., *Robot-assisted radical nephroureterectomy with extended template lymphadenectomy for upper tract urothelial carcinoma: An outcome analysis.* Indian J Urol, 2018. **34**(3): p. 212-218.

Follow up <1 year or unclear (cystectomy) (n=22)

1. *Multidomain Quantitative Recovery Following Radical Cystectomy for Patients Within the Robot-assisted Radical Cystectomy with Intracorporeal Urinary Diversion Versus Open Radical Cystectomy Randomised Controlled Trial: the First 30 Patients.* European urology, 2018. **74**(4): p. 531-534.
2. *Real-World Impact of Minimally Invasive Versus Open Radical Cystectomy on Perioperative Outcomes and Spending.* Urology, 2018.
3. Borza, T., et al., *No Differences in Population-based Readmissions After Open and Robotic-assisted Radical Cystectomy: Implications for Post-discharge Care.* Urology, 2017. **104**: p. 77-83.
4. Flamiatos, J.F., et al., *Open versus robot-assisted radical cystectomy: 30-day*

perioperative comparison and predictors for cost-to-patient, complication, and readmission. J Robot Surg, 2018.
5. Ko, O.S., et al., *Rates and Predictors of Conversion to Open Surgery During Minimally Invasive Radical Cystectomy.* J Endourol, 2018. **32**(6): p. 488-494.
6. Koie, T., et al., *The feasibility and effectiveness of robot-assisted radical cystectomy after neoadjuvant chemotherapy in patients with muscle-invasive bladder cancer.* Jpn J Clin Oncol, 2017. **47**(3): p. 252-256.
7. Kukreja, J.B., et al., *A comparison of pathologic and intermediate term oncologic outcomes following open and robotic radical cystectomy.* Journal of Clinical Oncology, 2019. **37**.
8. Leow, J.J., et al., *Propensity-matched comparison of morbidity and costs of open and robot-assisted radical cystectomies: a contemporary population-based analysis in the United States.* Eur Urol, 2014. **66**(3): p. 569-76.
9. Li, A.Y., et al., *Patient-Reported Convalescence and Quality of Life Recovery: A Comparison of Open and Robotic-Assisted Radical Cystectomy.* Surg Innov, 2016. **23**(6): p. 598-605.
10. Mally, D., et al., *Oncological outcome of robotic-assisted radical cystectomies compared to open radial cystectomies.* Oncology Research and Treatment, 2018. **41**: p. 205.
11. Matulewicz, R.S., et al., *National comparison of oncologic quality indicators between open and robotic-assisted radical cystectomy.* Urol Oncol, 2016. **34**(10): p. 431.e9-431.e15.
12. Modi, P.K., et al., *Real-World Impact of Minimally Invasive Versus Open Radical Cystectomy on Perioperative Outcomes and Spending.* Urology, 2019. **125**: p. 86-91.
13. Monn, M.F., et al., *National trends in the utilization of robotic-assisted radical cystectomy: an analysis using the Nationwide Inpatient Sample.* Urol Oncol, 2014. **32**(6): p. 785-90.
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15. Nazzani, S., et al., *Comparison of Perioperative Outcomes Between Open and Robotic Radical Cystectomy: A Population-Based Analysis.* J Endourol, 2018. **32**(8): p. 701-709.
16. Necchi, A., et al., *Robot-assisted Versus Open Radical Cystectomy in Patients Receiving Perioperative Chemotherapy for Muscle-invasive Bladder Cancer: The Oncologist's Perspective from a Multicentre Study.* Eur Urol Focus, 2017.
17. Pak, J.S., et al., *Utilization Trends and Short-term Outcomes of Robotic Versus Open Radical Cystectomy for Bladder Cancer.* Urology, 2017. **103**: p. 117-123.
18. Sharma, P., et al., *Surgical control and margin status after robotic and open cystectomy in high-risk cases: Caution or equivalence?* World J Urol, 2017. **35**(4): p. 657-663.
19. Soria, F., et al., *Robotic radical cystectomy is associated with shorter length of stay and less blood loss than open radical cystectomy: Results from a large multicenter retrospective cohort.* Journal of Urology, 2018. **199**(4): p. e812-e813.
20. Tan, W.S., et al., *Intracorporeal robot-assisted radical cystectomy, together with an enhanced recovery programme, improves postoperative outcomes by aggregating marginal gains.* BJU Int, 2018. **121**(4): p. 632-639.
21. Taylor, B., et al., *Does robotic cystectomy achieve oncologic efficacy for locally advanced bladder cancer?* Journal of Urology, 2018. **199**(4): p. e533.
22. Yu, H.Y., et al., *Comparative analysis of outcomes and costs following open radical*

cystectomy versus robot-assisted laparoscopic radical cystectomy: results from the US Nationwide Inpatient Sample. Eur Urol, 2012. **61**(6): p. 1239-44.

Follow up <3 years or unclear (partial nephrectomy) (n=63)

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2. Anderson, J.E., et al., *Hospital costs and length of stay related to robot-assisted versus open radical and partial nephrectomy for kidney cancer in the USA.* J Robot Surg, 2012. **6**(1): p. 19-22.
3. Anele, U., et al., *Robotic versus laparoscopic radical nephrectomy: A matched paired multicenter analysis (rosula group).* Journal of Urology, 2018. **199**(4): p. e787.
4. Arora, S., et al., *What is the hospital volume threshold to optimize inpatient complication rate after partial nephrectomy?* Urol Oncol, 2018. **36**(7): p. 339.e17-339.e23.
5. Autorino, R., et al., *Incidence and risk factors for 30-day readmission in patients undergoing nephrectomy procedures: a contemporary analysis of 5276 cases from the National Surgical Quality Improvement Program database.* Urology, 2015. **85**(4): p. 843-9.
6. Ayangbesan, A., et al., *Surgical approach does not impact margin status following partial nephrectomy for large renal masses.* J Endourol, 2018.
7. Banapour, P., et al., *Nephrometry score matched robotic vs laparoscopic vs open partial nephrectomy.* J Robot Surg, 2018.
8. Bertolo, R., et al., *Robot-assisted partial nephrectomy for CT2 renal tumors: Perioperative, functional and oncological outcomes from a multicenter analysis (the rosula project).* Journal of Urology, 2018. **199**(4): p. e540.
9. Bertolo, R., et al., *Pure laparoscopic versus robot-assisted partial nephrectomy for ct1b renal tumors: A single tertiary center experience.* Journal of Urology, 2018. **199**(4): p. e544.
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complications and renal function in patients undergoing partial nephrectomy for renal tumors. BJU Int, 2018.
18. Ficarra, VS, et al., *A multicentre matched-pair analysis comparing robot-assisted versus open partial nephrectomy.* BJU Int, 2014. **113**(6): p. 936-41.
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Sample Size <80 (n=84)

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