Retrospective analysis comparing robotic assisted with open partial nephrectomy in Canterbury

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Abstract

Robotic assisted partial nephrectomy (RAPN) is not currently offered in the public health system in New Zealand, but current research suggests there may be reduced complications and length of stay compared to open partial nephrectomy (OPN). The objective of this study was to retrospectively compare RAPN and OPN approaches in Canterbury, between Jan 2015–Oct 2018. The study showed no significant difference in all baseline characteristics between the two groups ($p < 0.05$), except positive resection margin, which showed a higher number with a resection margin (<1 mm for OPN vs. RAPN; 11 vs. 0, $p = 0.0048$). There was significant reduction in mean length of stay for RAPN (2.3 vs. 4.3 days, $p = 0.0001$) and number of complications (2 vs. 22, $p = 0.0002$) compared with OPN respectively. There was no significant difference in other perioperative variables. This study is consistent with current literature, showing a reduction in length of stay and number of complications for RAPN compared with OPN, and a lower rate of positive resection margins. Costs of providing RAPN therefore need to be considered to determine if there is justification for providing this service in the public health system. Future research could investigate using a longer follow-up period to analyse oncological outcomes, such as metastatic spread and recurrence.

Introduction

Current guidelines suggest removal of small renal masses (<4 cm) with nephron-sparing surgery when suspicious of malignancy.[1,2] Renal masses larger than this would impair a large proportion of the kidney, therefore an inability to preserve its function in nephron-sparing surgery. Nephron-sparing surgery is used to maintain the patient's kidney function, reducing risk of progression to chronic kidney disease.[1,2]

There is no difference in oncological outcomes (local/metastatic spread and recurrence) with tumours measuring <5 cm, therefore this is the treatment of choice if technically feasible, unless the tumour has suggestions of increased oncological potential.[2]

There are now many different approaches to nephron-sparing surgery: open, robotic, and laparoscopic. The laparoscopic approach is not often chosen due to its difficulty for many tumour locations, or for obese patients who increasingly make up the patient population. OPN is most often used in the public sector, but RAPN can now be used as a minimally invasive alternative to OPN in the private sector of New Zealand with the hope of reducing complications and enhancing performance. Two meta-analyses showed lower rates of complications with RAPN, as well as shorter length of stay and reduced transfusion requirements, compared with the OPN approach.[3,4] Xia et al carried out sensitivity analysis with exclusion of studies with obvious selection bias with regard to tumour complexity, allowing more accurate analysis of intra-operative factors.[3] Tsai et al also showed reduced blood loss for RAPN compared to OPN, particularly in highly complex renal masses, but also a longer operative time.[4] Xia et al and Tsai et al both had a large sample size, but inherent limitations involved in observational study.[3,4]

A reduction in mean length of stay with RAPN compared with OPN was demonstrated by several retrospective and prospective studies carried out since 2016.[5–9] Two retrospective studies also showed a reduction in intraoperative transfusion rates[5,6] and complications[8,10] with RAPN compared with OPN.

Overall, there is a need for well-designed randomised control trials with large sample sizes and longer follow-up times, as well as studies using local data. Robotic surgery is not currently used in the public health system in Canterbury, therefore it would be useful to analyse the patient benefit of RAPN compared with OPN using local data. If local data aligns with current literature showing a significant patient benefit, then a cost-benefit analysis could be carried out to determine the feasibility of its use in the Canterbury public health system. For this reason, a retrospective analysis was carried out comparing RAPN with OPN using patients in Canterbury. The aim of this study was to determine if there is any difference between RAPN and OPN in Canterbury with regard to perioperative variables and complications.

Methods

Study design and data collection

Data from all patients undergoing OPN in the Urology Department of Christchurch Hospital were retrospectively collected between Jan 2015–Oct 2018. All patients undergoing RAPN by the Urology Associates (private urologists in Canterbury) between these dates were also included. Exclusion criteria were paediatric patients or patients who were not undergoing tumour removal.

For each patient, we collected data on age, gender, perioperative factors (operative and ischaemic time, blood loss, peri- and post-operative complications within 30 days, and hospital stay), and tumour characteristics (tumour size, histotype, stage, and surgical margin status). Positive resection margin is the margin of surgical tissue that has no notable tumour within the resected tissue, determined through histology.

Data was collected through a combination of electronic records and operative notes, by two different people. Tumour size was determined using information from histology, and complications were recorded according to the Clavien-Dindo classification.[11] This is a classification system, which grades complications from 1–5, grade 5 being most severe.

Statistics

Categorical variables were compared using Fisher's exact two-tailed test, while continuous variables were compared, calculated using the unpaired t-test. All statistical analyses were carried out using Graphpad Prism.

Results

Preoperative characteristics

Overall, 69 patients underwent OPN (43) or RAPN (26) between Jan 2015–Oct 2018 through the Department of Urology in Christchurch Hospital and through the Canterbury Urology Associates respectively.

Table 1 shows that there was no significant difference in all baseline characteristics (age and gender, tumour size, location, histology, and stage) between the two groups ($p < 0.05$), except for positive resection margin. There was a higher number of patients with a positive resection margin of <1 mm in the OPN group compared with RAPN (11 vs. 0, respectively, $p = 0.0048$).

Table 1 Patient demographics and tumour characteristics stratified according to surgical approach

Variables	OPN (n=43)	RAPN (n=26)	P-value
Age	60.4	65.9	0.105
Gender			0.770
Male	31 (72.1%)	17 (65.4%)	
Female	12 (27.9%)	5 (19.2%)	
Tumour Size (mm)	31.4	2.9	0.436
Tumour location			0.505
Upper pole	15 (34.9%)	7 (26.9%)	
Mid pole	13 (30.2%)	3 (11.5%)	
Lower pole	14 (32.6%)	3 (11.5%)	
Histology			0.394
Clear cell RCC	24 (55.8%)	11 (42.3%)	
Papillary RCC	8 (18.6%)	5 (11.6%)	
Tubulocystic	1 (2.3%)	0 (0%)	
Multilocular cystic RCC	1 (2.3%)	0 (0%)	
Benign	9 (20.9%)	9 (34.6%)	
Tumour Stage			>0.999
pT1a	26 (60.4%)	17 (65.4%)	
pT1b	1 (2.3%)	2 (7.7%)	
pT3a	3 (7.0%)	0 (0%)	
pT1M1	1 (2.3%)	0 (0%)	
Positive surgical margin			0.0048
<0.1 mm	8 (18.6%)	0	
<1 mm	3 (7.0%)	0	

Table 2 shows that there was no significant difference in estimated blood loss, warm ischaemic time, operating time, return to theatre, and number of transfusions for RAPN compared to OPN, respectively. There was significant reduction in mean length of stay however, for RAPN compared with OPN (2.3 vs. 4.3 days, respectively, $p = 0.0001$).

Table 2 Perioperative data comparing open and robotic assisted partial nephrectomy

Perioperative variables	OPN (n=43)	RAPN (n=26)	P-value
Estimated blood loss (ml)	159.4	153.5	0.903
Warm ischaemic time (minutes)	14.2	16.2	0.260
Operation time (minutes)	148.5	150.7	0.900
Blood transfusion	2 (4.7%)	0	0.523
Return to theatre	2 (4.7%)	0	0.523
In hospital stay (days)	4.3	2.3	0.0001

Table 3 shows the complications for both groups using the Clavien-Dindo classification system. Overall, there was a reduced number of complications for RAPN compared with OPN (2 vs. 22, respectively, p = 0.0002). The complications for the OPN group were mostly grade 1 complications (13), however there were still a significant number of complications for grade 2a, grade 3, and grade 4 (five, two, and two, respectively) compared with RAPN, whose two complications were grade 2a.

Table 3 Complications according to the Clavien-Dindo classification comparing open and robotic assisted partial nephrectomy

	Open partial nephrectomy (n = 43)	Robotic assisted partial nephrectomy (n = 26)	P-value
Total complications	22	2	0.0002
Grade 1	13	–	
Pleural or peritoneal breach	4	–	
Prolonged pain	3	–	
Pneumothorax	2	–	
Incisional bulge	3	–	
Seroma	1	–	
Grade 2a	5	2	
Sepsis	2	1	
Need for blood transfusion	2		
Ileus	1	1	
Grade 2b	–	–	
Grade 3	2	–	
Post-op bleed requiring surgical revision	2	–	
Grade 4	2	–	
Pneumonia requiring ICU	1	–	
Perinephric haematoma requiring ICU	1	–	
Grade 5	–	–	

Discussion

The robot-assisted approach for partial nephrectomy is currently being used in many countries, due to being minimally invasive compared with OPN, with improved view, precision, and ergonomics compared with laparoscopic.[7] This study included 43 OPN patients and 26 RAPN patients, all with similar baseline characteristics ($p < 0.05$). As expected, there was a significant reduction in mean length of stay (2.3 vs. 4.3 days, p = 0.0001) and complications (2 vs. 22, p = 0.0002) for RAPN compared with OPN, respectively. This is consistent with current literature, which shows reduced number of complications and mean length of stay for RAPN.[3–9]

The study also showed that two OPN patients required transfusion compared with no RAPN patients, however this was not statistically significant (p = 0.523). Two previous studies showed no statistical difference between groups with regard to blood transfusion requirement, which is consistent with this result.[8,10] Several studies including two meta-analyses showed reduced transfusion requirements for RAPN compared with OPN.[3–6] The current study may not have had a large enough sample size to show any statistical significance for an uncommon outcome such as transfusion, therefore a larger study may be required to explore this result. This is the limitation of a retrospective cohort, which requires a large sample size for less common outcomes. The sample size may explain why we found no statistically significant difference in estimated blood loss between groups, although there was some missing data for this variable making it less reliable. Both meta-analyses and the retrospective study by Tan et al showed less estimated blood loss in the RAPN group compared to the open group.[3,4,9]

The statistical power of this study could have been improved if data were analysed New Zealand wide, rather than just Canterbury, although this would have required a lot more time and resources. Recruiting patients that had surgery prior to 2015 would have likely introduced more missing data, therefore this would not be a good solution to increasing the sample size.

In our study there were 11 patients with a resection margin of <1 mm for OPN compared with zero patients for RAPN (p = 0.0048). This result was consistent with a slightly larger study of 200 patients,[8] but many studies showed no significant difference in positive resection margin between RAPN and OPN.[3,7,8,10] It may be worthwhile looking at the way the pathologist reports the positive resection margin, and whether this has clinical significance. The tumour characteristics such as location, size, type, and grade were not significantly different between groups, therefore these factors are unlikely to be acting as confounding factors. A prospective study that involves a longer follow-up period, looking at oncological outcomes for patients in Canterbury would be needed to support this result and improve the level of evidence. Current literature suggests there is no difference in the long-term oncological outcomes between OPN and RAPN patients, although this evidence is limited.[1,2]

Other limitations of this study include the inherent differences in public compared to private care, including socioeconomic status, waiting times, and co-morbidities. The private data were also collected by a different person to the public data, but there was communication about how this was done to keep it consistent and reduce scope for error. Operative time for RAPN included anaesthetic time and occasionally other procedures, therefore an estimate was occasionally required making this result less reliable. Borghesi et al[8] and Tsai et al[4] showed a longer operative time for RAPN compared to OPN, while other studies showed no difference.[1,3,5,7] This included the meta-analysis by Xia et al, which showed no association after controlling for tumour complexity.[3]

Better quality evidence is required to limit confounding and selection bias. Unfortunately, a randomised control trial would not be possible in Canterbury due to RAPN not being available in the public system, and this may be considered unethical due to the amount of evidence showing benefits of RAPN compared with OPN. A prospective study could be considered in the future for the Canterbury region, to reduce bias associated with missing data and to support the current limited evidence. A longer follow-up period would be beneficial to compare oncological outcomes, as there is limited evidence looking at this. Further research could also look at more complex masses as well as patients with a body mass index of >30, which is a readily increasing demographic in the population.

In this audit and literature review I have focused on patient factors for RAPN compared to OPN. Other considerations to justify using robotic surgery for public cases include benefits of partial nephrectomy over radical nephrectomy, the number of patients per year that would benefit, as well as overall cost.

In conclusion, this retrospective audit for Canterbury data aligned with current literature to show that RAPN has a shorter mean length of stay and lower rate of complications compared with OPN. Interestingly, this study also showed a lower rate of positive resection margins in the RAPN group, compared with OPN. All other perioperative factors and tumour characteristics were similar between

the two groups, including operative time, warm ischaemic time, and transfusion rates. Further research to increase the level of evidence would be beneficial, as well as research into the costs involved in using RAPN for the public health system.

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