

Robotic Nephrectomy vs Open Nephrectomy: Comparison of Complications and Oncological Outcomes

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Background: Many patients present in the late stage of renal cell carcinoma (RCC) which need to be resected, there are two surgical approaches (open and robotic). We aim to identify and compare the complications and outcomes following radical robotic nephrectomy and open radical nephrectomy.

Materials and Method: Cross-sectional study, compares demographical characteristic, surgical procedure details, oncological results and operative complications between open and robotic. Patients were followed for six months after the surgery. Data were collected from the year of 2008 to 2016 for patients who underwent radical nephrectomy.

Results: The study included 70 patients, (n:42) 60% open and (n:28) 40% robotic. Mean age was 55±14 years. Demographics were similar in both groups. Mean blood loss was significantly higher in open nephrectomy (p=0.042). Mean operation time was almost similar. Mean hospitalization length was less by half in the robotic group (p=0.007). Mean tumor size was larger in open group by 2.2 cm (p=0.018). A high number of complications was noted in the open approach compared with robotic in most categories. Seventy-five percent of the complications occurred in the first month, and only twenty-five percent was between 1 to 6 months following the surgery.

Conclusion: Robotic radical nephrectomy for RCC has the advantage over open surgery in the amount of blood loss, operative time, hospitalization length and some complications.

Keywords: Renal cell carcinoma; surgical outcome; complication; robotic nephrectomy; radical nephrectomy

Introduction

Nephrectomy was firstly performed in the 1860s for the treatment of renal disease (1). Since Robson's first description of the radical nephrectomy for renal tumors in 1963, radical nephrectomy has been traditionally performed by open methods through a relatively large abdominal or flank incisions (2). Within the last

decade; the radical nephrectomy is more frequently performed using a laparoscopic approach and most recently using the da Vinci Surgical Robotic System (3, 4). Thousands of patients were saved annually by radical nephrectomy surgeries (5). Renal cell carcinoma (RCC) is the most lethal urologic cancer which

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represents 3.9% of all adult cancers, with a median age of 64 years at diagnosis (6).

In the United States, according to the American Cancer Society, expected 65,340 new cases and 14,970 deaths from kidney cancer will occur in 2018 (7). Surgery is the primary treatment for most RCC cases, and radical nephrectomy is performed whenever RCC tumors are not resectable using partial nephrectomy. The main concern with radical nephrectomy is negative impact on renal function (8, 9). With Increasing numbers of kidney and renal pelvis cancer, more research is being established to assess the efficacy of robotic nephrectomy, to reach a more suitable nephrectomy and surgical approach for each patient.

The study aimed to identify and compare the complications and the outcomes following radical robotic nephrectomy and open radical nephrectomy.

Materials and Method

The study is a cross-sectional study, compares demographical characteristic, surgical details, operative complications and oncological results between two types of surgical approach (open and robotic). It was conducted between 24 July 2016 and 24 August 2016 with the approval of the institutional review board. It included all patient who underwent radical nephrectomy using open and robotic surgical approach between 2008 January and 2016 August, for the reason of malignant kidney tumor at King Fahad Medical City (KFMC), Riyadh, Saudi Arabia. The study excluded all children (less than 18 years) and patient with missing files. Data were collected in term of demographical characteristics (age, gender, comorbidity height, weight, American Society of Anesthesiologists (ASA) score an indication for surgery), surgical

procedure details, oncological outcomes and operative complications following the surgery for six months. Electronic patient's records (CORTEX and HIM systems) were used to collect data at KFMC. Patients demographical characteristics were reported using descriptive statistics regarding the number, percentage, mean and standard deviation. T-test and Chi-square test were used to show if there is a relationship between demographics, surgical procedure details, oncological outcomes, and operative complications. P-value of 0.05 and a confidence interval of 95% was considered statistically significant. Statistical analysis was done using IBM SPSS Statistics (version 23 SPSS Inc., Chicago, IL, USA).

Results

The study included 70 patients, 60% (n=42) underwent an open radical nephrectomy and 40% (n=28) robotic radical nephrectomy. Table-1 shows the demographical characteristic of patients. The mean age was 55 ± 14 which was very similar for open and robotic ($p=0.75$). Gender distribution was equal between all groups ($p=0.77$). BMI and Co-morbidities were not significant between groups to expect for Coronary artery disease which was higher in the open group. American Society of Anesthesiologists (ASA) score was slightly higher in the open but did not show any significance. Most of the cases had an elective surgery except for a few cases (17%). The emergency surgeries were mostly through an open approach. Table-2 shows the surgical details of patients. Only seven patients were readmitted in the following 30 days. Mean blood loss was significantly higher in the open nephrectomy ($p=0.042$). Only four patient had a blood transfusion in the robotic approach and 16 patients in the open approach.

Table-1. Demographic values of the patients

Variables	Type of nephrectomy		Total	p
	Open (42)	Robotic (28)		
Mean Age years ($\pm$ SD)	55.2 (14.2)	56.4 (14)	55.7	0.748
Gender				
▪ Male	21	13	34	0.77
▪ Female	21	15	36	
BMI ($\pm$ SD)	31.1 (6.1)	36.1 (22)	33.2	0.166
Comorbidity				
▪ Obesity	26	19	45	0.704
▪ HTN	25	13	38	0.281
▪ DM	18	12	30	0.596
▪ Smoking	9	5	14	0.714
▪ CAD	11	2	13	0.045
Mean ASA score ($\pm$ SD)	2.5 (0.7)	2.3 (0.7)	2.41	0.220
Indication				
▪ Emergency	10	2	12	0.137
▪ Elective	32	26	58	

The mean operation time was almost similar. Mean hospitalization length was less by half in robotic group which was significant ($p=0.007$). Table-3 shows the oncological outcomes.

Table-2. Surgical procedure details

Variables	Open (42)	Robotic (28)	Total	P
Hospital readmission	4	3	7	0.321
Blood loss (ml)	1552 $\pm$ 2131 only 18 pt.	578 $\pm$ 844 only 9 pt.	1152	0.042
Transfusion units	5 $\pm$ 4.4 only 16 pt.	4.3 $\pm$ 3.8 only 4 pt.	4.9	0.743
Operation time (hours)	4:45 $\pm$ 1:58	4:18 $\pm$ 1:22	4:34	0.311
Hospital Stay (days)	7.6 $\pm$ 7.3	3.6 $\pm$ 1.5	6	0.007

Mean tumor size was larger in open group by 2.2 cm ($p=0.018$). Clear cell type was counted for 63% of the cases. Most of the tumors were of low stage and grade. Table-4 shows the operative complications during the six months following nephrectomy.

Table-3. Oncological outcomes

Variables	Open (42)	Robotic (28)	Total (70)	p
Tumor size (cm)	7.5 (3.7)	5.3 (3)	6.7	0.018
Type of Tumor				
▪ Clear Cell	22 (61%)	17 (68)	39 (63)	0.023
▪ Papillary RCC	1 (2.8%)	6 (24)	7 (11.5)	
▪ Chromo phobe	9 (25%)	1 (4)	10 (16.4)	
▪ Oncocytoma RCC	2 (5.6%)	1 (4)	3 (5)	
▪ Adeno carcinoma	1 (2.8%)	0	1 (1.6)	
▪ Sarcomatoid	1 (2.8)	0	1 (1.6)	
Stage (%)				
▪ T1	8	14	22	0.081
▪ T2	12	2	14	
▪ T3	5	6	11	
▪ T4	1	0	1	
Grade (Fuhrman) (%)				
▪ 1	5	10	15	0.130
▪ 2	20	11	31	
▪ 3	5	1	6	
▪ 4	3	2	5	
IVC involved (%)	7 (16.7)	1 (3.6)	8 (11.4)	0.192
Positive tumor margin (%)	2 (6.5)	0	2 (6.5)	0.608

A high number of complications was noted in the open approach compared with robotic in the most categories. Seventy-five percent of complications occurred in the first month, and only twenty-five percent was between 1 to 6 months following the surgery. Complications of

the period from 1 to 6 months were (fistula, chronic kidney disease, deep vein thrombosis, dialysis, pulmonary embolism, hemorrhage, vomiting).

Table 4. Operative complications during the 6 months following nephrectomy

Category	Surgery type		p
	Open (42)	Robotic (28)	
Gastrointestinal, n(%)	6 (14)	4 (14)	1
▪ Bowel obstruction	1	0	0.4
▪ Vomiting	3	3	0.6
▪ Abdominal distention	2	1	0.8
Wound, n(%)	4 (10)	1 (4)	0.3
▪ Wound infection	2	1	0.8
▪ Fistula	1	0	0.4
▪ Hernia	1	0	0.4
Infectious, n(%)	0	2 (7)	0.09
Fever	0	2	0.09
Cardiac, n(%)	3 (7)	2 (7)	1
▪ Tachycardia	2	1	0.8
▪ Tachypnea	0	1	0.2
▪ Hypotension	1	0	0.4
Genitourinary, n(%)	10 (24)	8 (29)	0.7
▪ Urine leak	1	0	0.4
▪ CKD	3	3	0.6
▪ Dialysis	6	3	0.7
▪ Hematuria	0	1	0.2
▪ Dysuria	0	1	0.2
Thromboembolic, n(%)	2 (5)	1 (4)	0.8
▪ DVT	1	0	0.4
▪ Pulmonary embolism	1	1	0.7
Pulmonary, n(%)	0	3 (11)	0.04
▪ Shortness of breath	0	1	0.2
▪ Pulmonary edema	0	1	0.2
▪ Atelectasis	0	1	0.2
Bleeding, n(%)	5 (12)	1 (4)	0.2
▪ Intra-operative	4	0	0.1
▪ Post-operative	1	1	0.7
Death, n(%)	2 (5)	0	0.2

The highest number of complications was related to Genitourinary followed by Gastro intestinal Complications. Two mortality cases were recorded during the six months.

Discussion

In this study, 70 radical nephrectomy patients (42 Open and 28 Robotic) cases were reviewed for demographics, surgical procedures detail and complications for the six months following the surgery. All demographic characteristics were similar between two groups, patients who underwent robotically had higher mean body mass index. By the literature (10), they found no significant difference between the two types of surgeries regarding body mass index and mean age. We have reported similarly in this study.

To evaluate the blood loss, we distinguished between the intraoperative and postoperative period. Open nephrectomy was associated with a higher amount of blood loss in comparison to robotic nephrectomy. That is due to factors such as IVC thrombus, tumor size, and anesthetic management. Blood loss and operation time showed comparable results to other studies (11,12). Very similar to the study of Bragayrac Patients who underwent robotic nephrectomy had a shorter mean length of stay (11). There was no difference in operation time and blood loss between obese and non-obese patients unlike the finding in other studies for obese and non-obese patients (13).

Surgery is the most prevalent treatment for the most kidney cancers, although active surveillance (observation) may be an option for some patients with small tumors. Open radical nephrectomy is more frequently used for the treatment of renal masses at KFMC as our findings show it was used in 60% of cases (42 times). While 40% had a radical robotic

nephrectomy (28 times). It is fair to say KPMC used the open approach more because most of the cases present at late and the tumor size becomes unresectable through robotic surgery. We had two patients with a positive surgical margin among 70 radical nephrectomies. Based on the traditional classification of RCC caval thrombi, (14) out of our eight patients, five had a sub-hepatic thrombus that could be easily removed during radical nephrectomy through a cavotomy. The other three patients with thrombus in the retrohepatic or supra hepatic IVC not reaching the right atrium was a challenge and required a hepatic surgeon's help. All of them were removed using open radical nephrectomy, excepts for one supra-hepatic thrombus that was removed using radical robotic nephrectomy.

Postoperative complications were collected for six months following the surgery. Complications might be associated with patients' previous medical condition. Postoperative complications may either be general or rather specifically related to kidney surgery. Common general postoperative complications include post operative fever, atelectasis, vomiting, wound infection. The pooled data of postoperative complication showed no significant difference in all complications rates, the complications tend to be more towards open procedure group in comparisons to robotic, but this difference was not statistically significant in all of the complications categories except for Pulmonary complication. Robotic nephrectomy had more complication compared to open the nephrectomy in pulmonary complication including shortness of breath, pulmonary edema, and atelectasis.

Most of the complications (n:40) 75% occurred in the first month following the nephrectomy

and only (n:13) 25% occurred between the first and sixth month following the surgery. Two patients died following radical nephrectomy within two months; both had open surgery, a malignant tumor with >5 cm in diameter and pathology stage of T₃ and T₄ associated with malignant inferior vena cava (IVC) involvement, the first case died due to septic shock and the second case due to a severe intra-abdominal hemorrhage.

There are several limitations in our study, in particular, the nature of any retrospective data collection and a small number of cases. Another limitation is that different surgeons performed open than the surgeon performing robotic cases, creating differences in operating time and outcomes due to the different surgical technique, experience, and different pathological stage. However, if one were to compare open and robotic from the same surgeon, selection of more difficult tumors for open only is more likely, thus comparing open and robotic from the same surgeon would introduce other factors that could create bias. Finally, it is likely that patients who underwent open surgery had more complicated and more advanced tumors and therefore were likely to have more complications.

Conclusion

In conclusion, patients with renal cell carcinoma who underwent robotic surgery has demonstrated favorable perioperative and postoperative outcomes over open surgery. The major advantages of robotic surgery were in blood loss, operative time and hospitalization length. The rate of complications was higher in open surgery. A prospective randomized trial with bigger sample size and longer follow up will help to determine the best surgical approach for better outcomes.

Conflict of Interests

Authors have no commercial relation or other associations, actual or potential, that might create a conflict of interests in connection with the submitted paper. The authors declare that there is no conflict of interests regarding the publication of this paper.

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