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Orginal Article

Navigating Excellence Unravelling Surgical Outcomes Of Robotic Assisted Radical Nephrectomy

Maryam Javaid, [1] Harris Hassan Qureshi,[2] Naveed Ahmed Mahar,[3] Riaz Hussain Laghari,[2] Rehan Mohsin,[4] Asad Shahzad Hasan[4]

[1,2,3,4-] *Department Of Urology, Sindh Institute Of Urology And Transplantation, Karachi, Pakistan.*

ABSTRACT

Objective: To assess the surgical outcomes of robotic-assisted radical nephrectomy, specifically focusing on early postoperative complications classified by the Clavien-Dindo classification system.

Study design: A Prospective Observational Study.

Duration and place of study. The Department of Urology, Sindh Institute of Urology and Transplantation (SIUT), Karachi, from October 2022 to September 2023

Material and Methods: This prospective observational study was conducted at the Department of Urology, Sindh Institute of Urology and Transplantation (SIUT), Karachi, from October 2022 to September 2023. The study enrolled patients aged 30 to 70 years diagnosed with renal cell carcinoma and undergoing robotic-assisted radical nephrectomy. Informed consent was obtained from patients or their caretakers after explaining the risks and benefits of the study. The outcome variable, postoperative complications, was assessed. Data collected were entered and analyzed using IBM SPSS v26.

Result: In this study, we enrolled 82 patients with renal cell carcinoma undergoing robot-assisted radical nephrectomy. Most of the patients in our study were male, 67.07%. Postoperative complications were reported in 12 (14.6%). Among 12 patients with postoperative complications, 33.3% were Clavien 1, 41.7% Clavien 2 and 16.7% were Clavien 3. However, no death was reported in our study cohort.

Conclusion: Our study findings indicate that robotic-assisted radical nephrectomy is safe. Most postoperative complications are Clavien grade I or II or can be managed conservatively.

Keywords: Modified Clavien Dindo Classification; Renal Cell Carcinoma; Radical Nephrectomy; Robotic Surgery.

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Correspondence: Harris Hassan Qureshi
Department Of Urology, Sindh Institute Of Urology And Transplantation, Karachi, Pakistan.
E-mail: dr_hhq@live.com
ORCID: 0000-0002-3068-324X
Cell No: +92 331 2515337

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INTRODUCTION

Renal cancer is a disease that is on the increase globally, as over 338,000 new incidences have been diagnosed each year, and this is expected to grow by 22 percent by the year 2020 (1). RCC is the most frequent type of kidney cancer (approximately 90 percent), and it has shown much concern in the specialty of urologic oncology. Among the contributing factors that have led to this increase in incidence is the increased and even widespread utilization of more advanced ways of performing sophisticated diagnostic techniques like ultrasound, computed tomography (CT) as well as magnetic resonance imaging (MRI) to be able to detect the renal tumors at lower way and in incidental forms without a patient presenting symptoms to accompanies it (2,3).Surgical intervention has been the standard conservative therapeutic approach to treating localized renal cancer, with Radical Nephrectomy (RN) used as the therapy of first choice when treating tumors that have reached stage T1b and 4T2, and other tumors that could not be treated with the nephron-sparing surgical procedure (NS surgery) (4). Radical nephrectomy may then be done most commonly by open, laparoscopic, or robot-assisted methods, nowadays depending on the condition of the patient, the complexity of the tumor, and the experience of the surgeon (5).In the last ten to fifteen years, Robot-Assisted Radical Nephrectomy (RARN) has become a popular procedure among urologic surgeons because of the potential benefits of this method in comparison with classical methods (6). As robotic systems like the da Vinci Surgical System are becoming more developed, RARN enables more extensive three-dimensional imaging, magnification and the expanded motions of the articulated instruments, and also the elimination of physiological tremors (7, 8). These technological aids are not only helping to enhance the accuracy and the ergonomic aspect of complex surgical operations, but also help in what can be called an intraoperative performance, especially when dealing with litigious anatomical scenarios (9).Numerous studies have shown that RARN has many perioperative advantages, such as less estimated blood loss (EBL), shorter length of hospital stays, less post-surgical pain, and a decrease in the use of analgesics, resulting in rapid recovery times (10). Notably, the recurrence rates and cancer-specific survival seem to fall in line with those of oncological outcomes that could be achieved upon merely W3471 wholesale using RARN as opposed to other methods, including open and laparoscopic radical nephrectomy, proving its oncological Safety and effectiveness (11).Despite these advantages, the problem of postoperative complications caused by RARN is relatively high. Complications reported compared with those seen in conventional surgery included longer surgical times, increased hospital expenses, risk of wound infections, post-surgical bleeding, atelectasis, and ileus, commonly in cases with higher American Society of Anesthesiologists (ASA) or extreme numbers of comorbidities (12). Insufficient surgical skills and the learning curve associated with robot-assisted surgery can also create more complications in some clinical environments (13).As an example, Spana et al. (14) indicated postoperative complications of 14.4 percent occurrence in RARN patients, with 4.9 percent of such complications occurring due to hemorrhage. According to Clavien-Dindo classification, Grade 1-II complications occurred in 76.1 percent of patients and Grade 3-IV in 23.9 percent. There were also a few other cases of intraoperative conversions as reported in the study: 0.7 percent to open or laparoscopic surgery and 1.6 percent to radical nephrectomy. In another study by Anderson et al. (15), the complication rate after surgery was 5.6 percent, and the conversion rate was 10.3 percent, highlighting the necessity of better surgical training and risk stratification in preoperative setup.It is also necessary to note that the majority of existing literature comparing RARN and open/laparoscopic procedures was developed in high-volume centers located in Western countries where access to robotic high-tech systems and special surgical education are more typical. Conversely, there is limited regional data regarding the profile of complications of RARN in South Asia and other resource-limited healthcare settings. This deficit has made region-specific evidence crucial because it makes it problematic to make clinical decisions and policy planning concerning the implementation of robotic surgery. Thus, this paper will examine and record the nature and rates of postoperative complications related to Robot-Assisted Radical Nephrectomy (RARN) in our institutional setting. The proposed study will provide valuable results that can be used to improve the protocol of surgical operations, staff education, and pathways of perioperative care based on local data analysis and using international benchmarks. Also, the research could be used in planning future clinical trials and guideline development that would maximize safety and results associated with robotic nephrectomy in various healthcare settings.

MATERIALS AND METHODS

This prospective cross-sectional study was carried out at the Department of Urology, Sindh Institute of Urology and Transplantation, Karachi, spanning from October 2022 to September 2023. The study included patients diagnosed with renal mass who met the inclusion criteria, comprising individuals of both genders aged between 30 and 70 years with clinical stage I-III renal mass on CT with contrast triphasic. Patients with bilateral renal masses, metastasis, recurrent renal mass, or an American Society of Anaesthesiologists (ASA) class greater than three were excluded. Informed written consent was obtained from each participant. Patients were enrolled using a non-probability consecutive sampling technique until the required sample size was attained. Sample size calculation was conducted using the WHO sample size calculator, considering a postoperative complication frequency of 5.6%[9] in patients undergoing robot-assisted radical nephrectomy, with a margin of error of 5% and a confidence level of 95%, resulting in a required sample size of 82. All patients were admitted the day before the scheduled Surgery. The robotic-assisted laparoscopic nephrectomy was performed using a transperitoneal approach, with the patient positioned in amodified flank position of 45 degrees. The pneumoperitoneum was established by inserting a 12mm camera port just lateral to the rectus abdominis at the level of the umbilicus using an open technique. Subsequently, four additional ports were inserted under direct vision: two robotic working ports (6.5mm each), one positioned at an ipsilateral midclavicular location below the tip of the 12th rib and the other at an ipsilateral midclavicular position just below the level of the umbilicus. Additionally, two assistant ports were placed in midline, one 5mm between the umbilicus and xiphoid process, and another 15mm port situated approximately 5 to 7 cm below the umbilicus (Figure 1). After establishing the placement of ports, the initial dissection was performed using a hook electrode on the lateral working robotic arm and bipolar Maryland forceps on the medial working robotic arm. Employing a trans peritoneal approach, the line of Toldt was incised. The bowel was then mobilized medially, with additional mobilization of the duodenum for right- sided tumours. A surgical assistant provided counter traction and suction using conventional laparoscopic instruments to facilitate dissection. The renal artery and vein were identified and individually dissected bluntly, followed by separate division using a hemlock by the assistant surgeon. The remaining kidney tissue was mobilized using a combination ofsharp and blunt dissection techniques. The ureter was identified inferiorly, clipped, and divided. Subsequently, the freed specimen was placed in a 15-mm EndoCatch bag by the assistant surgeon and removed intact by extending one of the midline ports approximately 7 cm. On the first postoperative day, standard serum chemistries and a complete blood count were analyzed. Early mobilization was initiated on the first postoperative day, and diets were advanced as tolerated with the passage of flatus. The urinary catheter was removed once the patient achieved full mobility, and the drain was removed when the output was less than 30 ml. Patients were deemed eligible for discharge upon meeting the following criteria: ambulation capability, absence of urinary catheter and drain, oral acceptance of food, and absence of surgery-related complications. All patients were followed up for 30 days to monitor for any complications. The Clavien classification system (CCS) was utilized to assess and categorize postoperative complications. Various patient variables, including age, gender, residence, weight, BMI, presence of diabetes mellitus (DM), hypertension (HTN), smoking history, duration of renal cell carcinoma (RCC), stage of RCC, duration of the surgical procedure, length of hospital stay, and American Society of Anesthesiologists (ASA) class were documented in the proforma for analysis. All data were entered and analyzed using the SPSS version.26.0. Continuous variables (age, family monthly income, height, weight, BMI, duration of carcinoma, duration of Surgery, and length of hospital stay) were presented as mean ± standard deviation. Categorical variables such as gender, residence, DM, HTN, smoking, stage of RCC, ASA class, and complication were expressed as frequencies and percentages. Stratification was performed for age, gender, residence, BMI, DM, HTN, smoking, duration of RCC, stage of RCC, duration of the procedure, length of hospital stays, and ASA class to assess their impact on complications. Post-stratification Chi-Square test or Fisher's Exact test, as appropriate, was applied with a significance level set at $P \leq 0.05$.

ETHICAL APPROVAL STATEMENT

This study was conducted in accordance with ethical guidelines and received ethical clearance from the Ethics Review Board (**ERB-891/02/2020)** under the supervision of Corresponding Author Harris Hassan Qureshi at the Department Of Urology, Sindh Institute Of Urology And Transplantation, Karachi, Pakistan. Approval was obtained prior to the commencement of the study to ensure compliance with both institutional and international standards for human subject research. Informed consent was obtained from all participants before their inclusion in the study.

RESULTS

There were 82 cases of patients diagnosed with renal cell carcinoma (RCC) during the study period, who were subjected to a robot-assisted radical nephrectomy (RARN). The average body mass index (BMI) in the patients was 25.77 +/- 4.22 kg/m 2 which shows they were mainly in normal range and overweight range. The average length of illness before the operation was 1.96 +/-3 months, and the average working time was 84.11+/-32.71 minutes. The postoperative recovery period was not too long and the average length of stay was 2.62 +/- 1.97 days (Table 1).Demographic analysis has shown that the population has been dominated by the male gender (67.07 percent), and a large percentage of the participants (71.95 percent) were the urban population. In the cohort, 8 patients (9.76%) were diabetes mellitus familiar, 19 patients (23.17%) had hypertension, and 12 patients (14.63%) were current or ex-smokers. This distribution represents the usual comorbidities considered common to the patients of RCC.Concerning the stage of the disease, most of the patients were diagnosed with Stage I RCC (48.78%), followed by Stage II (30.49%) and Stage III (20.73%), suggesting that the majority of tumors that were detected were of the early stage and this might be because there is more use of diagnostic imaging. The average of normal diameter measured using triphasic contrast CT scanning was 11.2 cm + 4.7 cm whereas the average normal diameter of the surgically excised specimen was 9.4 cm + 4.5 cm as illustrated in Figure 2.Twelve patients (14.6%) had postoperative problems, as international results show the percentage of RARN complications. Of patients with complications, 33.3 percent had Clavien-Dindo Grade 1 complicated, 41.7 percent had Grade 2 and 16.7 percent had Grade 3 complications. Notably, there were no intraoperative or postoperative deaths in the cohort of this study, which presents the relative safety of robotic option as employed in experienced hands.Additional stratification and further analysis on the postoperative complications were done in terms of some patient and procedural factors such as gender of the patient, the region of residence, income stratification, body mass index (BM), the length of time the patient had the illness, the time that the procedure took in operation, and time that he stayed in the hospital, comorbidities (diabetes, hypertension), smoking status, stage of RCC, and the ASA stratification. Table 2 demonstrates the outcomes of this stratified research and gives an understanding of the possible predictors of complications after RARN and the necessity of individualized-risks.

Figure 01: Clavien-Dindo Classification of Postoperative Complications and percentages.

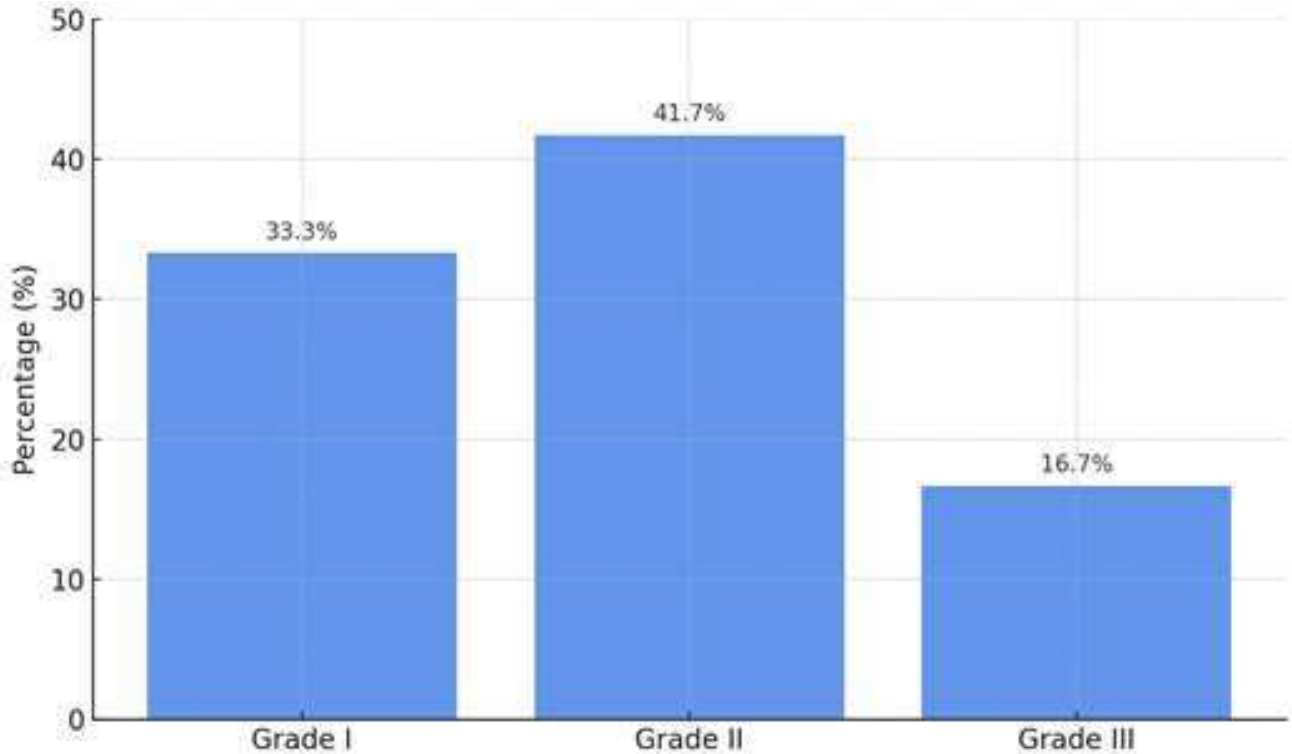

Figure 02: prevalence of diabetes, hypertension, and smoking history among the study participants.

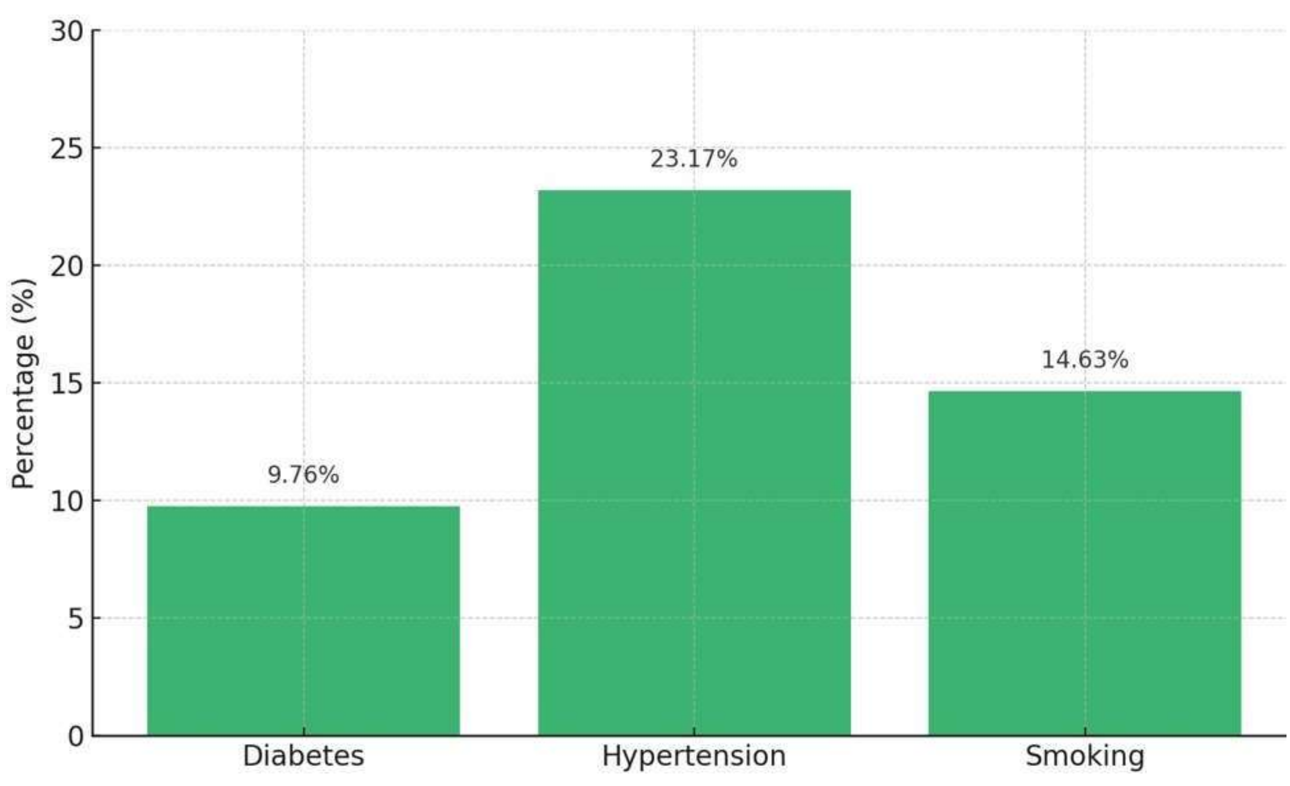

Table 1: Descriptive statistics and distribution of demographic and clinical characteristics among patients undergoing robot-assisted radical nephrectomy.

Descriptive Statistics	Height (cm)		164.38	**14.4**
	Weight (kg)		70.91	**12.92**
	BMI (Kg/m^2)		25.77	**4.22**
	Duration of Disease (months)		1.96	**3**
	Operative time (mins)		84.11	**32.71**
	Hospital Stay (Days)		2.62	**1.97**
			Frequency	**Percentage (%)**
	Gender	Male	55	**67.0**
		Female	27	**32.9**
	Place of residence	Urban	59	**71.9**
		Rural	23	**28.0**
	Diabetes	No	74	**90.2**
		Yes	8	**9.7**
	Hypertension	No	63	**76.8**
		Yes	19	**23.1**
	Smoking	No	70	**85.3**
		Yes	12	**14.6**
	Stage of RCC	I	40	**48.7**
		II	25	**30.4**
		III	17	**20.7**
	ASAClass	I	39	**47.5**
		II	42	**51.2**
		III	**1**	**1.2**

Table 2: Association between independent variables and postoperative complications amongpatients undergoing robot-assisted radical nephrectomy.

		NO		YES		
		N	%	N	%	
Gender	Male	46	83.6	09	16.3	**0.527**
	Female	24	88.8	03	11.1	
Residence	Urban	48	81.3	11	18.6	**0.100**
	Rural	22	95.6	01	4.3	
BMI	< 30	59	84.2	11	15.7	**0.504**
	≥30	11	91.6	01	8.3	
Duration of Disease	≤1	48	87.2	07	12.7	**0.486**
	>1	22	81.4	05	18.5	
Operative time	≤85	44	91.6	04	8.3	**0.055**
	>85	26	76.4	08	23.5	
Length of Hospital Stay	≤2	60	98.3	01	1.6	**<0.001**
	>2	10	47.6	11	52.3	
DM	NO	65	87.8	09	12.1	**0.054**
	YES	**05**	**62.5**	**03**	**37.5**	

Figure 03: Percentage-Based Summary Metrics In RARN Patients

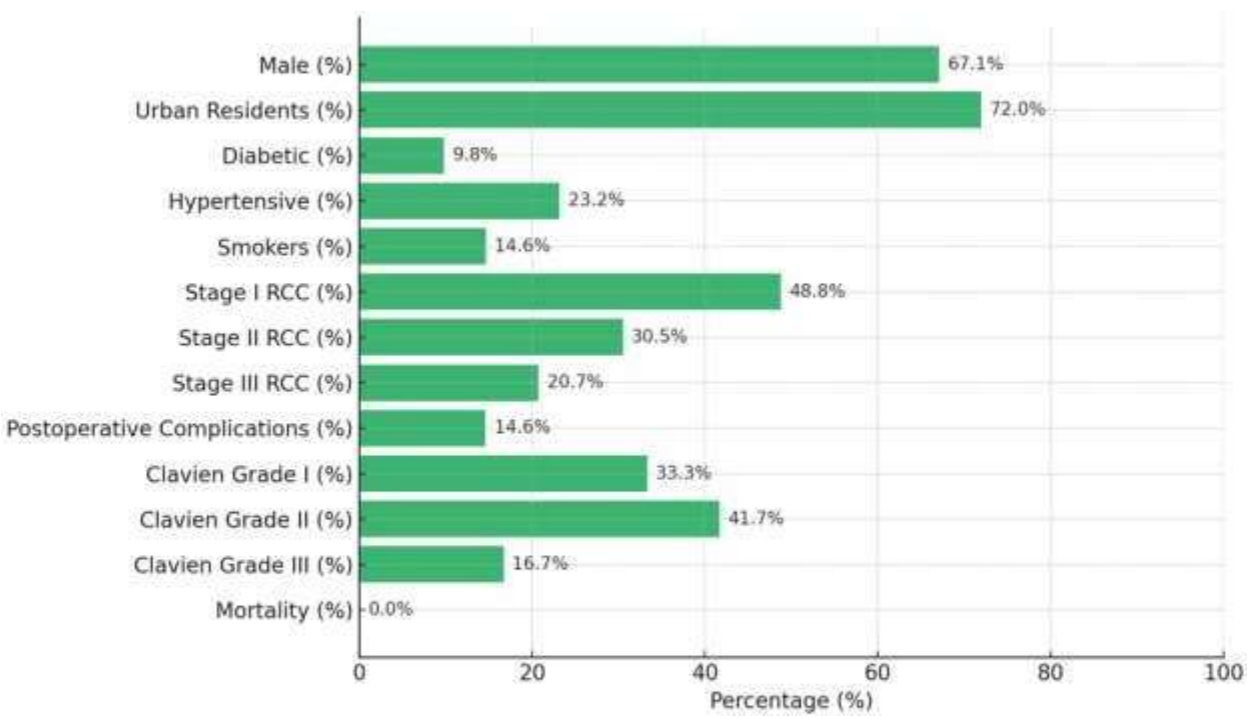

Figure 1: Schematic Pattern of Port Placement for Robot-assisted Radical Nephrectomy "

Figure 2: Surgical specimen of the excised kidney following robot-assisted radical nephrectomy.

DISCUSSION

Evidence has proven that robot-assisted nephrectomy is a viable and more favored minimally invasive strategy of nephron-sparing surgery, which has a significantly shorter learning curve compared to traditional laparoscopic nephrectomy (16,17). The robotic technique generates precision and flexibility due to the mechanical effect of the robotic instrumentation process, intuitive three-dimensional visualization, and warbled instruments. All of these features give more urologists confidence to change to robot-assisted platforms more easily, transitioning from open or laparoscopic modalities (18).Over the past few years, several quality research activities have demonstrated the clinical value of robotic-assisted nephrectomy to treat large, complex, and centrally placed renal masses, including those that are hilar, endophytic or centrally located renal tumors (1922). Such tumors are frequently considered to be high-risk for conventional minimally invasive methods because of their strategic locations in major vasculatures and collecting systems. Nevertheless, the improved ease and precision possible with robots have pushed the boundary of indications into complex cases, especially concerning a minimally invasive radical and partial nephrectomy.Notably, the outcomes in terms of oncology and functionality post-robotic-assisted nephrectomy are demonstrated to be similar to laparoscopic nephrectomy in terms of recurrence and maintained renal functions (23). Several multi-institutional, prospective studies have demonstrated equivalence in early oncologic outcomes and the complication spectrum of robotic compared to laparoscopic cohorts, indicating that robotic-assisted nephrectomy can be implemented safely and without the sacrifice of oncologic control (24,25).The perioperative complication rates represent one of the critical parameters of evaluating the safety profile of robotic-assisted nephrectomy that leads to the clinical adoption of the procedure. Nevertheless, the rate of complications differs significantly in the literature regarding the study design (prospective vs. retrospective), predetermined sample size, and utilization of unified classifications, including the Clavien-Dindo grading system (26,27). An early experience of robotic-assisted nephrectomy has reported complication rates of 0 to 20 percent (22,28). With 450 patients who have undergone robotic nephrectomy, a total of 15.8 percent were found to have complications, of which 1.8 percent were during the procedure and 14.4 percent after the procedure (28). The investigation failed to stratify the complications according to the degree of tumor complexity, as well as the factors related to the patient, thus limiting its generalizability.Our trial with 82 patients undergoing radical nephrectomy with the assistance of a robot recorded a complication rate after the surgery of 14.6 percent. This finding can be set alongside those of larger groups. Of these, 33.3 percent, 41.7 percent, and 16.7 percent were Clavien Grade I, Grade II, and Grade III complications, respectively. Strikingly, there were no mortalities, which supports the safety of RARN in patients who are appropriately chosen. These results are based on findings obtained earlier by Tanagho et al., who reported on 886 patients and stated an intraoperative complication rate of 2.6 percent, a postoperative rate of 13.0 percent, and a total of 15.6 percent. Among them, 30.9 percent of Clavien grade I postoperative complications, 46.0 percent of grade II, 15.1 percent of grade III, and 7.9 percent of grade IV occurred, none of which was mortal (29). Complications such as hemorrhage are some of the most common and potentially fatal events to experience in RARN. The transfusion rate in their massive series of laparoscopic partial nephrectomy (LPN) was 4.5 percent, and the mean estimated blood loss (EBL) was 300 mL, with the lower and upper range of 25 mL and up to 6,000 mL (30) reported by Gill et al. Scoll et al. reported a 3 percent postoperative blood transfusion rate and 1 percent embolization rate in one of the most extensive single institutional series completed, 100 cases of robotic partial nephrectomy (RPN); this is evidence of the necessity of hemostatic control during surgery (31).Another major issue that concerns the postoperative period is venous thromboembolism (VTE). In a report by Pettus et al., evidence has shown that 1.5 percent of all the patients who had partial and radical nephrectomy developed VTE, of which 0.6 percent and 0.9 percent experienced deep venous thrombosis and pulmonary embolism, respectively. Surprisingly, the type of surgical approach (open surgery, laparoscopic or robotic) did not make much difference regarding the occurrence of VTE (32). The authors wanted to warn about pharmacologic VTE prophylaxis routinely used during nephron-sparing surgery due to the low overall VTE rate and potential increased risk of causing renal parenchymal bleeding linked to anticoagulation.Another complication of concern is urinary fistulas. Report incidence is based on surgical technique: cumulative incidence point incidence of open nephron-sparing surgery is 7.4% with a range between 1.4 and 17.4%, and it is 3.1% with LPN (30,33). In robotic-assisted partial nephrectomy, a 2 percent urinary fistula rate occurred as reported by Scoll et al., indicating the effectiveness of the robotic component in limiting urinary tract injuries (34).Our study, however, is not without limitations, as these encouraging results indicate. To begin with, it is a single-center study with a small sample size, which may limit the generalizability of the results. Second, our study is retrospective and descriptive, which limits the development of the cause-and-effect approach between the surgical approach and outcome. Third, we did not record intraoperative complications that could also be used as confounders in the analysis of postoperative events. Lastly, types of complications and interventions were not categorized in detail, which could explain more about surgical morbidity (35).Finally, we have confirmed previous research findings that the safe and efficient method of radical nephrectomy with the assistance of robots allows effective treatment of the most complicated cases of the disease. Nevertheless, these findings should be confirmed by continuous prospective, multi-center trials. Furthermore, complication risk levels should be better stratified and perioperative management of these patients can be further optimized.

CONCLUSION

Robotic-assisted nephrectomy has an acceptably low complication rate, consistent with historical complication rates of open partial nephrectomy and laparoscopic nephrectomy. Most postoperative complications are Clavien grade I or II and can be managed without an invasive procedure. Despite the potential advantages of robotic-assisted nephrectomy, it remains a challenging operation that requires considerable robotic and laparoscopic experience. Further multicenter randomized controlled trials with larger sample sizes are needed to confirm the safety of robotic radical nephrectomy further.

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<u>Authors Contribution:</u>

Concept & Design of Study: Maryam Javaid, Harris Hassan Qureshi

Drafting: Naveed Ahmed Mahar, Riaz Hussain Laghari

Data Analysis: Maryam Javaid

Critical Review: Riaz Hussain Laghari

Final Approval of version: All Mention Authors Approved.

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