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Navigating Excellence: Unravelling Surgical Outcomes of Robotic Assisted Radical Nephrectomy

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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 analysed using IBM SPSS v26.

Result: In this study we enrolled 82 patients with renal cell carcinoma undergoing robot assisted radical nephrectomy. Most of the patient in our study were male 67.07%. Post-operative complication was reported in 12 (14.6%). Among 12 patients with post operative complication, 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 indicates 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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INTRODUCTION

Globally, the incidence of renal cancer is increasing, with over 338,000 new cases diagnosed annually, projected to rise by 22% by 2020. Recently, the increased use of diagnostic radiology and advancements in this field have led to the incidental diagnosis of renal cancer at a very early stage in most cases (1). The mainstay of renal cancer treatment remains surgical resection, with radical nephrectomy (RN) being considered the primary treatment for T1b and >T2 and for those renal tumours that are not amenable to nephron-sparing surgery. The National Comprehensive Cancer Network guidelines (NCCN) (1, 4) recommend performing radical nephrectomy using open, laparoscopic, and robotic approaches. During the past decade, Robot-Assisted Radical Nephrectomy (RARN) has been widely adopted worldwide by urological surgeons and is also gaining popularity over traditional approaches (2), as it has many advantages over other modalities, including enhanced 3-dimensional visualization and magnification, increased degrees of freedom of surgical instruments, and the elimination of hand tremors, along with facilitating complex reconstruction and suturing in RN (5). This technique is not only providing ergonomic benefits for the surgeon, but a robotic approach for the RN has also been associated with reduced estimated blood loss (EBL), postoperative pain, a decreased length of hospital stay, and earlier recovery while achieving equivalent cancer control and convalescence(4).Besides the merits of RARN, studies have been done in the past that showed certain perioperative complications associated with the robotic approach to RN as compared to other conventional modalities. Patients who underwent RARN had longer operative time, higher hospital costs, wound infection, delayed bleeding, atelectasis, and ileus in the postoperative period. Some of the factors that can be responsible for these complications are lack of expertise, patients with higher ASA scores (American Society of Anaesthesiology), and known prior co-morbidities (3, 6, 7). A study by Spana et al. reported postoperative complications in 14.4% of patients. Haemorrhage developed in 4.9%. As classified by the Clavien system, complications were grade I–II in 76.1% of cases and grade III–IV in 23.9%. Robotic-assisted partial nephrectomy was converted to open or conventional laparoscopic surgery in 3 patients (0.7%) and to radical nephrectomy in 7 (1.6%). (8). Another study reported that postoperative complications in patients undergoing robot-assisted radical nephrectomy were 5.6%. However, conversion was reported at 10.3% (9). Most studies predominantly examine postoperative complications in open and laparoscopic nephrectomy, with limited literature available from our region on postoperative complications in robot-assisted radical nephrectomy (RARN). The comparative advantages between robotic and other minimally invasive techniques remain a subject of debate due to the scarcity of data on postoperative complications associated with RARN. Therefore, our study aims to assess postoperative complications following the RARN procedure. The insights gained from our study may facilitate modifications in surgical techniques and pave the way for future research to identify factors contributing to postoperative complications.

MATERIALS AND METHODS

With approval from the institute's ethics review board, 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 3 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 a modified flank position of 45 degrees. 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 a bipolar Maryland forceps on the medial working robotic arm. Employing a transperitoneal 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 countertraction 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 hemolock by the assistant surgeon. The remaining kidney tissue was mobilized using a combination of sharp 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 analysed. 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 Anaesthesiologists (ASA) class were documented in the proforma for analysis.All data were entered and analysed using 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 $P \leq 0.05$.

RESULTS

In this study we enrolled 82 patients with renal cell carcinoma undergoing robot assisted radical nephrectomy. The mean BMI of patient was 25.77 ± 4.22 Kg/m^2. However mean duration of disease, duration of procedure and length of hospital stay was 1.96 ± 3 months, 84.11 ± 32.71 mins and 2.62 ± 1.97 days (Table 1). Most of the patient in our study were male 67.07%. Among 82 patient, majority of patient belongs to urban area 71.95%. Furthermore, 08 (9.76%) patients were diabetics, 19 (23.17%) were hypertensive and 12 (14.63%) were smoker. However, Stage I renal cell carcinoma was most common 48.78% followed by stage II 30.49% and stage III 20.73%. Mean size of the tumour on CT triphasic was 11.2 ± 4.7cm. Mean size of the retrieved specimen was 9.4±4.5cm [Figure 2].Post-operative complication was reported in 12 (14.6%). Among 12 patients with post operative complication, 33.3% were Clavien 1, 41.7% Clavien 2 and 16.7% were Clavien 3. However, no death was reported in our study cohort. Stratification of post operative complication with respect to gender, residence, income, BMI, duration of renal cell carcinoma, duration of procedure, length of hospital stay, diabetes, hypertension, smoking, stage of renal cell carcinoma and ASA class shown in Table 2.

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

			Mean	SD
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
	ASA Class	I	39	47.5
		II	42	51.2
		III	1	1.2

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

Independent variables		**Post-operative complication**				p-value
		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	

HTN	NO	58	92.0	05	7.9	0.002
	YES	05	62.5	07	36.8	
Smoking	NO	58	92.0	11	15.7	0.50
	YES	11	91.6	01	8.3	
Stage of RCC	I	1.36	90	04	10	0.40
	II	1.21	84	04	16	
	III	13	76.4	04	23.5	
ASA Class	I	1.34	87.1	05	12.8	0.81
	II	1.35	83.3	07	16.7	
	III	01	100	00	00	

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

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

DISCUSSION

Early reports indicate that robotic-assisted nephrectomy has a relatively shorter learning curve than laparoscopic nephrectomy [10,11] and, hence, may facilitate the use of minimally invasive nephron-sparing surgery. Numerous studies have now described the utility of robotic-assisted nephrectomy in managing large and complex renal masses, including endophytic, central, and hilar lesions [12-15]. Furthermore, multiple studies have demonstrated equivalent preliminary oncologic and functional outcomes between robotic-assisted nephrectomy and laparoscopic nephrectomy. [16] Complication rates can be used to evaluate the safety of novel surgical procedures. However, reported complication rates can vary substantially depending on prospective vs. retrospective reporting and the appropriate use of standardized classification criteria. [17] The initial robotic-assisted nephrectomy series reported complication rates of 0% to 20%. [15] Spana et al. [8], in their analysis of 450 robotically assisted nephrectomy patients, reported an overall complication rate of 15.8%, including intraoperative and postoperative complications of 1.8% and 14.4%, respectively. However, this smaller cohort may overlook rare complications, and there was no analysis to stratify complications based on tumour complexity. In our recent analysis of 82 robotically assisted nephrectomy patients, we reported an overall post-operative complication rate of 14.6%. Among 12 patients with postoperative complications, 33.3% were Clavien 1, 41.7% were Clavien 2, and 16.7% were Clavien 3. However, our study cohort did not report any deaths. Tanagho et al. [18] present complication rates for 886 patients, stratified by tumour anatomic characteristics. The study found an intraoperative complication rate of 2.6%, a postoperative complication rate of 13.0%, and an overall complication rate of 15.6%. Among postoperative complications, 30.9% were Clavien 1, 46.0% were Clavien 2, 15.1% were Clavien 3, and 7.9% were Clavien 4. Again, no complication-related deaths occurred. Haemorrhagic complications are one of the most common, potentially life-threatening events associated with robotic nephrectomy. Gill et al. [19] reported a 4.5% transfusion rate and 300 mL mean estimated blood loss (range 25 to 6,000) in the LPN group. Scoll et al. recently reported 100 RPN cases, which represent the largest single institutional series to date [20]. They identified a 3% postoperative transfusion rate and a 1% interventional embolization rate. Pettus et al. [21] reported a 1.5% venous thromboembolism (VTE) incidence in patients undergoing any type of partial or radical nephrectomy, including deep venous thrombosis and pulmonary embolism in 0.6% and 0.9% respectively. Notably, open, partial, or laparoscopic procedure types had no impact on the VTE incidence. They argued against routine pharmacological prophylaxis during NSS, citing the low incidence of perioperative VTE and the high risk of renal parenchymal bleeding at the resection site. The cumulative incidence of urinary fistulas after open NSS is reportedly 7.4% (range: 1.4% to 17.4%), and for LPN, it is reportedly 3.1%. [19,22] Similarly, Scoll et al. reported a 2% urinary fistula rate in their RPN series. [20] Our study's findings are subject to several limitations. Firstly, as a single-centre study with a limited sample size, our findings may have limited generalizability to a larger population. Secondly, our study is descriptive in nature, which hampers the establishment of a causal relationship between the intervention and the outcomes. Thirdly, we did not document intraoperative complications, which are significant confounding variables for postoperative complications. Finally, our study did not specify the types of complications and interventions, which is also considered a major limitation.

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 multicentred randomized controlled trial with larger sample size are needed to further confirm the safety of robotic radical nephrectomy.

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