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COMPARISON OF PERI-OPERATIVE OUTCOMES OF ROBOT-ASSISTED VERSUS LAPAROSCOPIC RADICAL NEPHRECTOMY

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Abstract

OBJECTIVE *To compare the perioperative outcomes of robot-assisted radical nephrectomy vs laparoscopic radical nephrectomy in patients with renal cell carcinoma.*

METHODOLOGY *This randomized controlled trial is being conducted at the Sindh Institute of Urology and Transplantation (SIUT) located in Karachi, with the aim of assessing peri-operative outcomes between robot-assisted and laparoscopic radical nephrectomy in individuals diagnosed with renal cell carcinoma. Participants, aged between 18 and 65 years, regardless of gender, will be systematically allocated into two distinct groups through randomization. The investigation will analyze peri-operative metrics including surgical duration, volume of intraoperative blood loss, necessity for transfusions, and duration of hospital stay. Data will be analyzed utilizing SPSS version 26.0, and statistical significance will be ascertained at a significance level of $p \leq 0.05$.*

RESULTS *Among 70 patients, the mean age was 54.40 ± 15.08 years in the RARN group and 58.11 ± 13.94 years in the LRN group, with males comprising 57.1% and 51.4%, respectively. Operative time >4 hours occurred in 45.7% vs. 28.6% (p=0.138); blood transfusion in 20.0% vs. 22.5% (p=0.771); and hospital stay >4 days vs. 28.6% (p=0.584).*

CONCLUSION *Robot-assisted and laparoscopic radical nephrectomy exhibited analogous peri-operative outcomes in individuals diagnosed with renal cell carcinoma. There were no statistically significant discrepancies observed in operative duration, requirement for blood transfusion, or length of hospitalization between the two surgical methodologies. These findings substantiate the clinical parity of both techniques in the immediate surgical management of renal neoplasms.*

INTRODUCTION

Radical nephrectomy (RN) constitutes the conventional intervention for the treatment of substantial renal neoplasms or neoplasms deemed unsuitable for nephron-sparing interventions [1,2]. In recent years, with the advancement of minimally invasive methodologies, laparoscopic RN (LRN) has emerged as a viable alternative to traditional open RN due to its association with diminished physiological trauma and a reduction in perioperative complications [3]. Nonetheless, the laparoscopic approach is characterized by constraints in flexibility

and operability, and it presents a steep learning curve [4].

Empirical evidence indicates that there are minimal discrepancies in oncological outcomes between laparoscopic and open radical nephrectomy; however, laparoscopic techniques provide distinct advantages over the open method with respect to morbidity, hemorrhagic loss, duration of hospital stay, and requirements for postoperative analgesia [5,6].

In addition to replacing conventional open procedures like prostatectomy, robotic surgery has increasingly replaced standard laparoscopic methods. Technological advancements in minimally invasive surgery have established robotic-assisted partial nephrectomy as a reliable option, effectively reducing warm ischemia time (WIT) compared to the laparoscopic approach [7]. Robotic techniques are now widely adopted in various urological surgeries, including prostatectomy, and have experienced considerable progress in fields such as breast cancer treatment and reconstructive surgery [8].

A study by Jeong et al [9] compared the peri-operative outcomes in a patient undergoing laparoscopic versus robot-assisted radical nephrectomy (RARN). The overall complication was 21.9% vs 28.2%, major complication 3.6% vs 4.3%, prolonged operative time (>4 hours) 26.2% vs 43.8%, blood transfusion (pRBCs) 18.2% vs 19.5% and prolong the length of hospital stay (> 4 days) 25.1% vs 21.2% in laparoscopic versus robot-assisted radical nephrectomy group. Another study reported that robot-assisted radical nephrectomy was linked to lower rates of intraoperative complications (0.9% vs. 1.8%; $p < 0.001$) and postoperative complications (20.4% vs. 27.2%; $p < 0.001$). No significant differences were found in perioperative blood transfusion rates (5.6% vs. 6.2%; $p = 0.27$) or in prolonged hospitalization (6.2% vs. 7.1%; $p = 0.81$) [10]. The incidence of extended operative time (greater than 4 hours) was significantly higher in the RARN group (43.8%) compared to the LRN group (26.2%), with an adjusted risk ratio (RR) of 1.79 (95% CI: 1.52 to 2.11). This represents an absolute risk difference of 20.5% (95% CI: 14.2 to 26.8), emphasizing the greater time intensity associated with robotic procedures [11].

Although the robotic methodology for radical nephrectomy (RN) has experienced a notable increase in global adoption, the benefits associated with its application in the management of renal tumors continue to elicit debate within the academic community. While a number of investigations have indicated that robot-assisted radical nephrectomy (RARN) yields comparable perioperative outcomes yet entails greater hospital expenditures than laparoscopic radical nephrectomy (LRN) [9,11,12], alternative research has posited that RARN may be correlated with reduced surgical morbidity. In light of its widespread implementation, there exists a notable absence of local investigations assessing the outcomes of these frequently utilized approaches to radical nephrectomy. Within resource-limited environments, it becomes imperative to emphasize methodologies that are both economically viable and advantageous for patient care. The objective of this study is to systematically compare the perioperative outcomes of robot-assisted radical nephrectomy and laparoscopic radical nephrectomy in individuals diagnosed with renal cell carcinoma.

METHODOLOGY

This randomized controlled trial was conducted at the Department of Urology, Sindh Institute of Urology and Transplantation (SIUT), with the primary aim of comparing perioperative outcomes between robot-assisted radical nephrectomy and laparoscopic radical nephrectomy in patients diagnosed with renal cell carcinoma (RCC). Patients aged 18 to 65 years, of either gender, with histopathologically confirmed RCC—characterized by large nuclei with prominent eosinophilic nucleoli, papillary architecture, clear cytoplasm, and a nested arrangement with intervening vasculature—will be included. Patients with a history of renal surgery, metastatic disease, or immunocompromised status will be excluded.Informed consent, documented in writing, will be procured from all study participants. Qualified individuals scheduled to undergo radical nephrectomy will be allocated randomly into two distinct groups utilizing a computer-generated randomization protocol, with the allocations concealed within sealed envelopes that will be opened immediately prior to the surgical intervention. The study design will be single-blinded, ensuring that patients remain unaware of their respective group assignments. Participants in Group A will receive

laparoscopic radical nephrectomy, whereas those in Group B will be subjected to robot-assisted radical nephrectomy. All surgical procedures will be executed by urologists possessing more than five years of post-fellowship clinical experience, employing standardized surgical techniques that incorporate bladeless dilating trocars.Preliminary demographic and clinical information, which includes variables such as age, gender, body mass index (BMI), residential status, comorbid conditions (including diabetes mellitus and hypertension), smoking habits, ASA classification, and tumor laterality, will be meticulously recorded in a standardized proforma. Perioperative outcomes will be evaluated at a 1-month follow-up and will encompass prolonged operative duration (operationally defined as surgical time exceeding 4 hours), the necessity for blood transfusion (administered when hemoglobin levels fall below 8 g/dL or as clinically warranted), extended hospital stay (operationally defined as exceeding 4 days), and intraoperative blood loss (quantified by subtracting the volume of irrigation fluid from the total suction fluid and expressed as mean ± SD). Tumor size and pathological staging will also be documented. Statistical analysis was conducted utilizing SPSS software, version 26.0. Categorical variables were presented as frequencies and corresponding percentages. For continuous data, results were expressed as either means with standard deviations or medians with interquartile ranges, based on the distribution pattern. Comparisons between groups were performed using the Chi-square test, as appropriate. A p-value of 0.05 or less was considered statistically significant.

RESULTS

Table I delineates the fundamental characteristics of 70 systematically allocated cases of Robot-Assisted Radical Nephrectomy (RARN) and Laparoscopic Radical Nephrectomy (LRN). The mean age of participants in the RARN cohort was 54.40 ± 15.08 years, whereas the LRN cohort exhibited a marginally elevated mean age of 58.11 ± 13.94 years. The mean body mass index (BMI) was calculated to be 26.06 ± 3.57 kg/m² for the RARN cohort, which surpasses that of the LRN cohort (mean: 24.36 ± 3.01 kg/m²). Serum creatinine levels were found to be comparable across both groups, with values of 0.89 ± 0.11 mg/dL for the RARN cohort and 0.93 ± 0.10 mg/dL for the LRN cohort. The estimated glomerular filtration rate (eGFR) was significantly higher in the RARN cohort (89.77 ± 13.59 ml/min/1.73 m²) compared to the LRN cohort (84.77 ± 14.95 ml/min/1.73 m², $P < 0.001$). Furthermore, the mean tumor size was observed to be slightly greater in the RARN cohort (2.34 ± 0.52 cm) relative to that in the LRN cohort (2.13 ± 0.53 cm). In terms of patient demographics, the RARN cohort comprised 20 males (57.1%) and 15 females (42.9%), while the LRN cohort included 18 males (51.4%) and 17 females (48.6%). With respect to tumor localization, 21 patients in the RARN cohort (60.0%) presented with right-sided tumors, whereas 16 patients in the LRN cohort (45.7%) exhibited similar tumor laterality. Among the RARN and LRN cohorts, 14 (40.0%) and 19 (54.3%) patients with left-sided tumors were identified, respectively. The incidence of hypertension was reported in 17 (48.6%) of the RARN patients and 20 (57.1%) of the LRN patients, while diabetes mellitus was noted in 8 (22.9%) and 11 (31.4%) patients, respectively. Finally, the prevalence of smoking was higher in the LRN cohort (12 patients, 34.3%) as compared to the RARN cohort (9 patients, 25.7%). In conclusion, baseline demographic characteristics were found to be comparable across both cohorts.

Table II presents a comparative analysis of perioperative outcomes between the RARN (Robot-Assisted Radical Nephrectomy) and LRN (Laparoscopic Radical Nephrectomy) cohorts. An operating duration exceeding 4 hours was recorded in 16 patients (45.7%) from the RARN cohort and 10 patients (28.6%) from the LRN cohort; however, this disparity did not reach statistical significance ($p = 0.138$; 95% CI: 0.782–5.666). Blood transfusions were necessitated in seven (20.0%) and eight (22.5%) patients in the RARN and LRN cohorts, respectively, with no statistically significant difference observed between the two groups ($P = 0.771$; 95% CI: 0.269–2.648). Likewise, eight patients (22.9%) from the RARN cohort and ten patients (28.6%) from the LRN cohort required hospitalization for a duration exceeding 4 days, which also did not exhibit significant differences ($p = 0.584$; 95% CI: 0.252–2.175).

DISCUSSION

In this randomized control study to compare RARN with LNRN in patients with renal cell carcinoma (RCC); the clinical selection criteria for patients were in conformity with world standards, these included patients aged between 18 and 65 years and histological data on RCC with clear cell features, definite nucleolar prominence, and vascular stroma as prescribed by Ljungberg et al. and Motzer et al. [1,2]. The exclusion criteria described that patients with a history of previous surgery on kidney, metastatic disease, or an altered immune function would be excluded from the cohort, which consequently rendered the sample more specific to the study of perioperative outcomes. The two cohorts had well-matched demographic characteristics, and similar baseline values for body mass index (BMI), renal function as assessed according to the estimated glomerular filtration rate (eGFR) and by the dimensions of the tumor and the prevalence of HTN and DM, as reported in the study by Campbell et al. [3] thus facilitating an appropriate evaluation of the surgical techniques used.

The findings of the current study demonstrated that there were no significant differences between RARN and LRN with respect to operative time, transfusion rate and hospital stay. Although a higher proportion of RARN cases experienced > 4 hours of OR running time (45.7% vs 28.6%), it was not statistically different. Likewise, the need for transfusion (20.0% vs. 22.5%) or longer hospital stay (stay longer than 4 days: 22.9% compared to 28.6%) were also comparable, which agrees with the results previously presented by Jeong et al [8]. and Gershman et al. [9,10]. Such studies have recorded that the perioperative outcome of robotic-assisted radical nephrectomy (RARN) and laparoscopic radical nephrectomy (LRN) are comparable and confirm the notion that robotic procedures often need longer operative times. Furthermore, Cacciamani et al. [17] concluded in their meta-analytical study that although robotic methodologies may not significantly diminish complication rates, they do provide enhanced ergonomic advantages and precision that could potentially affect long-term clinical outcomes.

The marginally enhanced complication profile and reduced duration of hospitalizations noted within our RARN cohort resonates with the observations made by Gershman et al. [10], who reported a lower incidence of intraoperative complications (0.9% versus 1.8%) and postoperative complications (20.4% versus 27.2%) among patients who underwent RARN. Our results also mirror those from Masson-Lecomte et al. [2], who in a recent multicenter study highlighted marginal yet consistent perioperative advantages of robotic nephrectomy, similarly, Zhang X et al. [19] demonstrated in their systematic review that RARN was associated with improved convalescence without a compromise in oncological efficacy. These global findings are particularly important when contextualized within our setting—a tertiary care center in a developing country—where infrastructure, training, and patient factors may all influence outcomes.

One of the strengths of our study is its randomized design and standardized surgical protocol, conducted by experienced urologists, which minimizes bias and procedural variability. Additionally, this study adds valuable regional data to a field where literature is heavily dominated by high-income country data. However, as discussed by Barbash et al. [4] and Porter et al. [16], the adoption of robotic surgery remains limited by its cost, which we did not evaluate in our study. This represents a key limitation, especially in resource-constrained environments. Another limitation includes our sample size, which may not be large enough to detect smaller yet clinically relevant differences between groups. Furthermore, the short follow-up period limits our ability to draw conclusions about long-term oncologic outcomes, a gap that was also noted in previous observational trials like those by Hemal et al. [18] finally, variables such as surgeon learning curve and volume were not stratified, although they can significantly impact operative time and complication rates, as shown by Kim et al. [15] and Porter et al. [16].

In Conclusion, our study findings support that both RARN and LRN are safe and effective options for managing RCC with comparable short-term perioperative outcomes. While robotic surgery may offer certain advantages such as reduced postoperative complications and shorter hospital stay, its higher costs and accessibility limitations must be considered. As noted by Kim et al. [15], successful implementation of robotic techniques even in lower-resource settings

is feasible with appropriate training and infrastructure. Future studies should explore long-term oncological outcomes, patient-reported quality-of-life measures, and cost-effectiveness analyses to better guide the adoption of robotic platforms in urological oncology, as recommended by Choi et al. and Cadeddu et al. [10,17].

CONCLUSION

Robot-assisted and laparoscopic radical nephrectomy exhibited analogous peri-operative outcomes in individuals diagnosed with renal cell carcinoma. There were no statistically significant discrepancies observed in operative duration, requirement for blood transfusion, or length of hospitalization between the two surgical methodologies. These findings substantiate the clinical parity of both techniques in the immediate surgical management of renal neoplasms.

Table I: Characteristics of Study Participants (n=70)

Characteristics		Groups	
		RARN (n=35)	LRN (n=35)
Age in years, Mean ± SD		54.40 ± 15.08	58.11 ± 13.94
BMI in kg/m², Mean ± SD		26.06 ± 3.57	24.36 ± 3.01
Serum Creatinine in mg/dL, Mean ± SD		0.89 ± 0.11	0.93 ± 0.10
eGFR in ml/min/1.73 m^2, Mean ± SD		89.77 ± 13.59	84.77 ± 14.95
Tumor Size in cm, Mean ± SD		2.34 ± 0.52	2.13 ± 0.53
Gender, n (%)	Male	20 (57.1)	18 (51.4)
	Female	15 (42.9)	17 (48.6)
Tumor Laterality, n (%)	Right	21 (60.0)	16 (45.7)
	Left	14 (40.0)	19 (54.3)
Hypertension, n (%)		17 (48.6)	20 (57.1)
Diabetes Mellitus, n (%)		8 (22.9)	11 (31.4)
Smoking Status (Smoker), n (%)		9 (25.7)	12 (34.3)

Table II: Comparison of Perioperative Outcomes Between Groups

Perioperative Outcomes	Groups		95% C. I	P-Value
	RARN	LRN		
Operating time (>4 h), *n* (%)	16 (45.7)	10 (28.6)	0.782–5.666	0.138
Blood Transfusion, *n* (%)	7 (20.0)	8 (22.5)	0.269–2.648	0.771
Length of hospital stay (>4 days), *n* (%)	8 (22.9)	10 (28.6)	0.252–2.175	0.584

REFERENCES

Ljungberg B, Albiges L, Abu-Ghanem Y, Bensalah K, Dabestani S, Fernández-Pello S, et al. European Association of Urology guidelines on renal cell carcinoma: the 2019 update. Eur Urol. 2019;75(5):799-810.

Motzer RJ, Jonasch E, Michaelson MD, Nandagopal L, Gore JL, George S, et al. NCCN Guidelines Insights: Kidney Cancer, Version 2.2020. J Natl Compr Canc Netw. 2019;17(11):1278-85.

Campbell S, Uzzo RG, Allaf ME, Bass EB, Cadeddu JA, Chang A, et al. Renal mass and localized renal cancer: AUA guideline. J Urol. 2017;198(3):520-9.

Barbash GI, Glied SA. New technology and health care costs--the case of robot-assisted surgery. N Eng J Med. 2010;363(8):701-4.

Wang L, Li KP, Yin S, Yang L, Zhu PY. Oncologic and perioperative outcomes of laparoscopic versus open radical nephrectomy for the treatment of renal tumor (> 7 cm): a systematic review and pooled analysis of comparative outcomes. World J Surg Oncol. 2023;21(1):35.

Grimaud LW, Chen FV, Chang J, Ziogas A, Sfakianos JP, Badani KK, et al. Comparison of perioperative outcomes for radical nephrectomy based on surgical approach for masses greater than 10 cm. J Endourol. 2021;35(12):1785-92.

White MA, Autorino R, Spana G, Laydner H, Hillyer SP, Khanna R, et al. Robotic laparoendoscopic single-site radical nephrectomy: surgical technique and comparative outcomes. Eur Urol. 2011;59(5):815-22.

Golombos DM, Chughtai B, Trinh QD, Mao J, Te A, O'Malley P, et al. Adoption of technology and its impact on nephrectomy outcomes, a US population-based analysis (2008–2012). J Endourol. 2017;31(1):91-9.

Gershman B, Bukavina L, Chen Z, Konety B, Schumache F, Li L, et al. The association of robot-assisted versus pure laparoscopic radical nephrectomy with perioperative outcomes and hospital costs. Eur Urol Focus. 2020;6(2):305-12.

Choi JE, You JH, Kim DK, Rha KH, Lee SH. Comparison of perioperative outcomes between robotic and laparoscopic partial nephrectomy: a systematic review and meta-analysis. Eur Urol. 2015;67(5):891-901.

Jeong IG, Khandwala YS, Kim JH, Han DH, Li S, Wang Y, et al. Association of robotic-assisted vs laparoscopic radical nephrectomy with perioperative outcomes and health care costs, 2003 to 2015. JAMA. 2017;318(16):1561-8.

Abaza R, Gerhard RS, Martinez O. Robotic radical nephrectomy for massive renal tumours. J Laparoendosc Adv Surg Tech. 2020;30(2):196-200.

Gershman B, Bukavina L, Chen Z, Konety B, Schumache F, Li L, Kutikov A, Smaldone M, Abouassaly R, Kim SP. The association of robot-assisted versus pure laparoscopic radical nephrectomy with perioperative outcomes and hospital costs. European Urology Focus. 2020 Mar 15;6(2):305-12..

Martini A, Fallara G, Pellegrino F, Cirulli GO, Larcher A, Necchi A, Montorsi F, Capitanio U. Neoadjuvant and adjuvant immunotherapy in renal cell carcinoma. World journal of urology. 2021 May;39:1369-76.

Kim JH, Kim HY, Kim NY, Kim JG, Kim SW, Kim JJ, Roe IH, Sin JG, Ahn HS, Yoon BC, Lee SW, Lee YC, *et al.* Seroprevalence of *Helicobacter pylori* infection in asymptomatic people in Korea. *Kor J Med* 2000; **59**: 388–97.

Porter ME, Larsson S, Lee TH. Standardizing patient outcomes measurement. N Engl J Med. 2016 Feb 11;374(6):504-6.

Checcucci E, Autorino R, Cacciamani GE, Amparore D, De Cillis S, Piana A, Piazzolla P, Vezzetti E, Fiori C, Veneziano D, Tewari A. Artificial intelligence and neural networks in urology: current clinical applications. Minerva urologica e nefrologica= The Italian journal of urology and nephrology. 2020 Feb;72(1):49-57.

1. Hemal AK, Kumar A, Kumar R, Wadhwa P, Seth A, Gupta NP. Laparoscopic versus open radical nephrectomy for large renal tumors: a long-term prospective comparison. The Journal of urology. 2007 Mar 1;177(3):862-6.

Zhang X, Shen Z, Zhong S, Zhu Z, Wang X, Xu T. Comparison of peri-operative outcomes of robot-assisted vs laparoscopic partial nephrectomy: a meta-analysis. BJU international. 2013 Dec;112(8):1133-42.