ORIGINAL ARTICLE

https://doi.org/10.1590/1806-9282.20230825

Early outcomes of robotic retroperitoneal partial nephrectomy: evaluating surgical success with margin, ischemia, and complication score

Sahin Kilic[1*], Murat Sambel[1], Mehmet Resat Inal[1], Batuhan Furkan Berk[1], Kayhan Yilmaz[1], Mahmut Taha Olcucu[1], Mutlu Ates[1]

SUMMARY

OBJECTIVE: The objective of this study was to evaluate the minimum number of required cases for successful robotic retroperitoneal partial nephrectomy for an experienced surgeon in transperitoneal robotic surgery.

METHODS: Our prospectively collected clinic database was evaluated retrospectively, and 50 patients who underwent robotic retroperitoneal partial nephrectomy by a single experienced surgeon from January 2019 to February 2023 were included in this study. Demographic and perioperative data and R.E.N.A.L. nephrometry scores were noted. margin, ischemia, and complication score was used to predict surgical success. Receiver operating characteristic curve analysis was used to determine how many cases were required to achieve margin, ischemia, and complication score positivity and to apply the off-clamp technique. Also, the first 25 patients were assigned to Group 1 and the second 25 patients to Group 2, and the data were compared between the groups.

RESULTS: The patients' demographic data and tumor characteristics were similar in the groups. The off-clamp technique and sutureless technique rates in Group 2 were significantly higher than that in Group 1. Margin, ischemia, and complication score positivity was observed in 60% (n=15) of Group 1 and 96% (n=24) of Group 2. At receiver operating characteristic curve analysis, the 25th and later cases were statistically significant in terms of margin, ischemia, and complication score positivity. In terms of performing surgery with the off-clamp technique, the 28th and subsequent cases were statistically significant.

CONCLUSION: A total of 25 or more cases appear to be sufficient to provide optimal surgical results in robotic retroperitoneal partial nephrectomy for an experienced surgeon.

KEYWORDS: Renal. Renal cell carcinoma. Robotic. Retroperitoneal. Partial. Nephrectomy.

INTRODUCTION

Renal cell cancer (RCC) is the third most common urological cancer[1]. Partial nephrectomy (PN) is the principal treatment method of cT1 stage RCC[2]. Robotic PN can be performed using a transperitoneal or retroperitoneal approach. Almost all urologists have become familiar with the transperitoneal method because of its prominent anatomical landmarks, easy trocar placement, and more frequent use in resident training. Although the robotic retroperitoneal approach has advantages, especially in posterior-located tumors, it is not used in many urology clinics due to technical difficulties and it is thought that the learning curve is steep.

The most important goal in PN surgery is to achieve successful oncological results without complications and preserve renal functions (trifecta)[3]. In addition, various scoring systems have been developed to interpret successful PN surgery, such as the margin, ischemia, and complication (MIC) score[4]. The most important factor that affects the success of PN and MIC scores is the experience of the surgeon[5]. The purpose of this study,was to evaluate the minimum number of required cases for successful robotic retroperitoneal partial nephrectomy (RRPN) surgery for an experienced surgeon in transperitoneal robotic surgery.

METHODS

Patients and data collection

Following the institutional clinical research ethics committee approval (no. 22/10, dated 08/12/2022), we reviewed our clinic database which is routinely and prospectively collected.

[1]Antalya Training and Research Hospital, Department of Urology – Antalya, Turkey.

*Corresponding author: sahinkilic84@hotmail.com

Conflicts of interest: the authors declare there is no conflicts of interest. Funding: none.

Received on July 06, 2023. Accepted on August 26, 2023.

Patients with previous histories of ipsilateral kidney surgery, solitary kidney, bilateral kidney tumors, and incomplete data were excluded. A total of 50 patients who underwent RRPN between January 2019 and February 2023 and completed at least 3 months of postoperative follow-up were included in this study. All RRPN procedures were performed by a single experienced surgeon (MA). Demographic, clinical, and perioperative data, R.E.N.A.L. nephrometry and MIC scores, pre- and post-operative third-month laboratory findings, complications, and pathology results were analyzed. These 50 patients were subsequently divided into two groups according to their operation dates. The first 25 patients constituted Group 1 and the second 25 patients constituted Group 2.

R.E.N.A.L. nephrometry scores were calculated as described by Kutikov[6]. Total operation time, console time, renal artery separation time, renography time, amount of bleeding, and Ischemia time in on-clamp PN operations were analyzed. Surgical margin (SM) negativity in pathology reports, Ischemia time less than 20 min, and absence of complication were defined as MIC score positivity (+)[4].

Surgical technique

The Da Vinci Xi (Intuitive Surgical, Sunnyvale, CA, USA) robotic surgery system was used in the operations. All operations were performed with the patient in the 90° angle lateral decubitus position and tumor side up. A standard retroperitoneal radical nephrectomy (RN) four-arm approach port configuration was employed.

The kidney was subsequently released over the psoas muscle. Anatomical landmarks (the ureter and vena cava or aorta) were identified. The renal artery was found and separated with a vessel loop. Subsequently, Gerota's fascia was incised, and renal mass was dissected and enucleated using a robotic bipolar dissector and monopolar scissors. Mass dissection and enucleation were started with the off-clamp technique in all cases. However, the on-clamp technique was applied in cases in which adequate hemostasis could not be achieved with electrocoagulation or suturing during mass enucleation. Renography was performed with two layers of running sutures. A 3-0 monofilament barbed suture (V-Loc™, Medtronic) was used for the deep layer, and a 2-0 polyglactin suture was used for the cortical layer. Cortical layer sutures were secured on the renal capsule using the sliding clip technique (Figure 1).

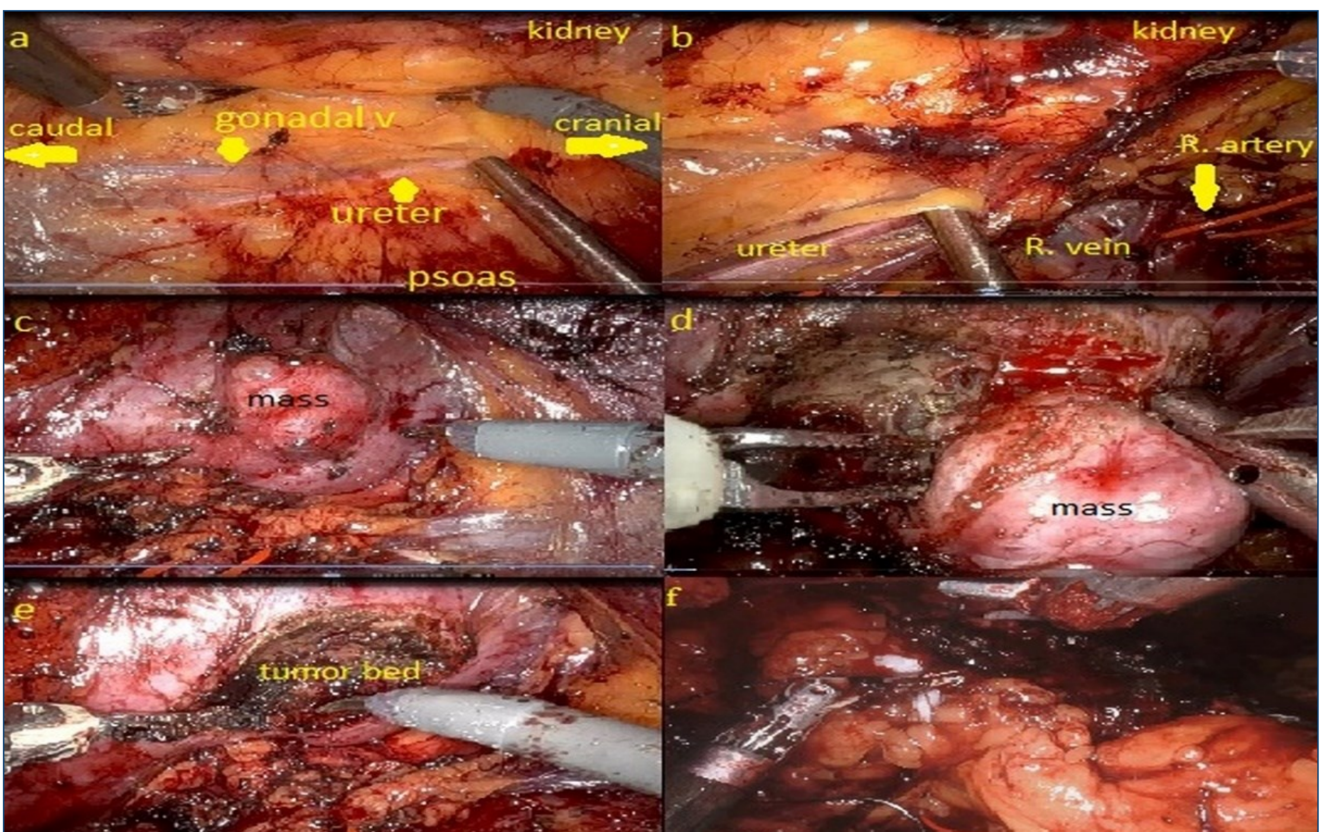

Figure 1. Surgical steps of robotic retroperitoneal partial nephrectomy. (a) Identification of the ureter and gonadal vein in left robotic retroperitoneal partial nephrectomy. (b) Separation of the renal artery and renal vein in left robotic retroperitoneal partial nephrectomy. (c) Incision of Gerota's fascia and identification of the mass in the left kidney. (d) Enucleation and excision of the mass. (e) Tumor bed after excision of the mass. (f) Running suture renography with the sliding clip technique.

Renography was not performed (sutureless surgery) in cases in which complete hemostasis was achieved with bipolar and monopolar energy electrocoagulation, the pelvicalyceal system and vascular structures were preserved, and only a hemostatic patch (Veriset™, Medtronic) was placed on the tumor bed. The operation was terminated with drain insertion.

Statistical analysis

Statistical analyses were performed using SPSS version 15.0 for the Windows software (SPSS, Chicago, IL, USA) program. The Shapiro-Wilk test was performed to determine the normality of distributions for continuous variables. Normally distributed continuous variables were compared using the Student's t-test, and non-normally distributed variables using the Mann–Whitney U test. Pearson's chi-square or Fisher's exact test was applied for categorical data. Normally distributed continuous variables were expressed as mean plus standard deviation (SD), and non-normally distributed variables were expressed as median. Categorical variables were expressed as numbers and percentages. Receiver operating characteristic (ROC) curve analysis was used to determine the number of cases required to provide sufficient surgical experience for achieving MIC score positivity and to apply the off-clamp technique. p-value less than 0.05 were regarded as significant.

RESULTS

Demographic data, tumor characteristics, and R.E.N.A.L. nephrometry scores of patients were similar among the groups (Table 1). There was no significant difference between the groups

Table 1. Patients' tumor characteristics and surgical and functional results.

		Group 1 (n=25)	Group 2 (n=25)	p-value
Age (years)		54.76±14.51	59.64±11.84	
Gender	Female (n, %)	6 (24)	7 (28)	
	Male (n, %)	19 (76)	18 (72)	
BMI (kg/m^2)		27.2±3.62	26.48±3.45	
Tumor side	Right (n, %)	14 (56)	14 (56)	
	Left (n, %)	11 (44)	11 (44)	
Clinic tumor size (cm)		3.65±1.40	3.44±1.21	>0.05
R.E.N.A.L. nephrometry score		6 (4–10)	6 (4–10)	
Mass Location	Anterior (n, %)	3 (12)	6 (24)	
	Posterior (n, %)	22 (88)	19 (76)	
Renal artery separation time (min)		18.52	18.24	
Console time (min)		147.36±55.93	141.16±35.38	
Renography time (min, n)		21.44±1.95 (25)	20.64±2.87 (11)	
Sutureless (n, %)		**0 (0.00)**	**14 (56.0)**	**<0.001**
Off-clamp (n, %)		**12 (48.0)**	**22 (88.0)**	**0.002**
Ischemia time (min, n)		**27.69±9.99** (13)	**17.33±2.5** (3)	**0.051**
Estimated blood loss (mL)		150 (30–500)	120 (30–500)	
Preoperative Hb level (g/dL)		13.93±0.33	14.22±0.36	
Postoperative Hb level (g/dL)		12.97±0.35	12.66±0.35	
Preoperative creatinine level (mg/dL)		0.96±0.03	1.04±0.04	
3rd month creatinine level (mg/dL)		0.98±0.03	1.04±0.04	
Postoperative third month eGFR		80.48±3.20	74.60±3.68	>0.05
Surgical margin positivity (n, %)		5 (20)	1 (4)	
°Malign (n)		23	21	
°°Clear cell		14	14	
°°Papillary		4	4	
°°Oncocytic-chromophobe		5	3	
MIC score positivity (n, %)		**15 (60)**	**24 (96)**	**0.002**

Bold indicates statistically significant values.

in terms of preoperative mean serum creatinine levels, eGFR levels, total operation times, or mean renal artery separation times. However, the mean renography time was significantly shorter in Group 2 (p<0.05). Mean console times tended to become shorter from Group 1 to Group 2 (147.4±56 and 141.2±36 min, respectively).

The off-clamp technique (zero Ischemia) ratios in Group 1 and Group 2 were 48% (n=12) and 88% (n=22), respectively, and significantly higher in Group 2 (p=0.002). In addition, while no sutureless surgery was performed in Group 1, 14 (56%) patients in Group 2 underwent sutureless RRPN (p<0.001). When the sutureless operation patients were excluded, the mean renography time in Group 2 was 20.64±2.87 min and similar to that in Group 1 (Table 1).

Although 14 patients underwent sutureless and clampless RRPN in Group 2, no significant difference was observed between the groups in terms of mean intraoperative blood loss and postoperative Hb levels. Four patients received postoperative single-unit red blood cell suspension transfusion in all patients. Ureteral injury developed in one case in Group 1 as a major complication, and a perioperative ureteroureterostomy was performed. No patient was converted to open surgery. The median time to return of bowel functions (flatulence) was 1 day, and drain removal times and lengths of hospital stay were 3 days in two groups. Prolonged urinary drainage was seen in one patient in Group 2 who underwent sutureless surgery and spontaneously terminated on the 32nd day with D-J stent placement.

There was no statistical difference between the groups in terms of pathological tumor sizes. SM positivity was detected in five cases in Group 1 and one case in Group 2. There was no difference between the groups in terms of pathological benign-malignant tumor rates and malignant subtypes. There was also no significant difference in terms of mean creatinine levels and eGFR averages in the postoperative third month. MIC score positivity reached 60% (n=15) and 96% (n=24) in Groups 1 and 2, respectively, and was significantly higher in Group 2 (p=0.002) (Table 1).

At ROC curve analysis of all RRPN (n=50) operations listed chronologically according to the date of operation, the 28th case and later were statistically significant in terms of off-clamp (zero ischemic) technique surgery (AUC=0.78, 95%CI 0.638–0.924, p=0.001). In terms of MIC score positivity, the 25th case and later were statistically significant at ROC curve analysis (AUC=0.78, 95%CI 0.644–0.918, p=0.005).

The median follow-up period was 13.28 months (3–51.87) for all cases and 30.58 months (7.93–51.57) for the SM-positive cases. Local tumor recurrence was observed in two patients without SM positivity in the first year.

DISCUSSION

The principal therapeutic step in non-metastatic RCC is PN or RN. The positive effects of PN on renal functions and cardiac disease risk have previously been demonstrated in cT1-stage renal tumors[2]. Achieving low complication rates and short hospital stays in surgical treatment is important in terms of patient health and effective use of the healthcare workforce. RRPN provides advantages such as shorter renal artery separation and surgery time, a short bowel function recovery time, and shorter hospital stays compared with the transperitoneal approach, according to the existing medical literature[7]. In addition, RRPN is advantageous in posteriorly located renal tumors and in patients with previous histories of abdominal surgery[8].

The mean renal artery separation time for all patients was approximately 18 min, which is shorter than the results of studies (21–41 min) in the literature[9]. Bowel function recovery time and length of hospital stay were 1 and 3 days, respectively, and consistent with the previous literature[10].

Margin, ischemia, and complication score positivity rates of 55–96.7% have been reported in different studies[11,12]. MIC score positivity was achieved in 39 (78%) cases among all patients in this study. However, the MIC score positivity rate approached 96% in Group 2. In addition, ROC curve analysis showed that the 25th and subsequent cases were significant in terms of providing MIC score positivity and also emphasized the importance of surgeon experience.

The upper limit of renal Ischemia time for maximum preservation of renal functions in the on-clamp technique has been reported at 20–25 min in different studies[13]. On-clamp technique was applied in 32% (n=16) of all cases in this study, and the mean renal Ischemia time was calculated as 25.75±9.91 min. However, the on-clamp technique was applied to only 12% (n=3) of the cases in Group 2.

Greater bleeding may be expected in the off-clamp technique. In this study, although the off-clamp technique rates differed significantly between Groups 1 and 2, no difference in mean blood loss was observed between the groups. This can be attributed to the powerful robotic monopolar and bipolar electrocoagulation in the off-clamp technique surgeries. In addition, ROC curve analysis showed that the 28th and subsequent cases were significant in terms of off-clamp technique surgery.

Sutureless PN studies have appeared in different publications since 2003[14]. These have reported that complete hemostasis can be achieved by means of electrocoagulation and placing hemostatic agents on the tumor bed, with no complications in some PN case series[15]. Sutureless PN is applied with the idea that the renal arcuate arteries can be preserved, renal medulla Ischemia can be minimized, glomerular loss can be reduced, and saturation-caused bleeding may be avoided[16]. Although all the groups in this study registered similar nephrometry scores, the sutureless technique was applied only in Group 2. Sutureless PN is possible with increased surgical experience.

Renal artery separation times were similar in the groups. This was attributed to the fact that the basic steps before separating the renal artery, such as creating an adequate working area by releasing the posterior and superior aspects of the kidney and identifying the ureter and the main vascular structures, were performed respectively in each case. No difference was observed in renography times between the groups, and this shows that, despite an increase in surgical experience, there was no decrease in the time spent by the surgeon on basic safety precautions.

SM positivity was detected in six (12%) cases, a figure that appears to be at the upper limit compared with the previous literature[17]. No recurrence or metastasis was detected in any SM-positive case.

CONCLUSION

Considering the anatomical locations of the urological organs, urologists will inevitably need to perform laparoscopic retroperitoneal surgery. This study suggests that 25 or more operations provide optimal surgical outcomes in RRPN for an experienced surgeon.

AUTHORS' CONTRIBUTIONS

SK: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing – original draft, Writing – review & editing. **MA:** Conceptualization, Investigation, Methodology, Project administration, Resources, Software, Writing – review & editing. **MRI:** Data curation, Investigation. **BFB:** Data curation, Investigation. **MS:** Formal Analysis, Investigation, Resources, Visualization, Writing – review & editing. **KY:** Formal Analysis, Investigation, Validation. **MTO:** Formal Analysis, Investigation, Validation.

REFERENCES

1. U.S. Cancer Statistics. United States cancer statistics: data visualizations. Cancer statistics at a glance. 2023. [cited on 2023 Oct 30]. Available from: https://gis.cdc.gov/Cancer/USCS/?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcancer%2Fdataviz%2Findex.htm#/AtAGlance/
2. Ljungberg B, Albiges L, Bedke J, Bex A, Capitanio U, Giles RH, et al. EAU guidelines on renal cell carcinoma. European association of urology. 2023. [cited on 2023 June 22]. Available from: https://uroweb.org/guidelines/renal-cell-carcinoma
3. Porpiglia F, Mari A, Amparore D, Fiori C, Antonelli A, Artibani W, et al. Transperitoneal vs retroperitoneal minimally invasive partial nephrectomy: comparison of perioperative outcomes and functional follow-up in a large multi-institutional cohort (the RECORD 2 project). Surg Endosc. 2021;35(8):4295-304. https://doi.org/10.1007/s00464-020-07919-4
4. Buffi N, Lista G, Larcher A, Lughezzani G, Ficarra V, Cestari A, et al. Margin, ischemia, and complications (MIC) score in partial nephrectomy: a new system for evaluating achievement of optimal outcomes in nephron-sparing surgery. Eur Urol. 2012;62(4):617-8. https://doi.org/10.1016/j.eururo.2012.06.001
5. Sciorio C, Prontera PP, Scuzzarella S, Verze P, Spirito L, Romano L, et al. Predictors of surgical outcomes of retroperitoneal laparoscopic partial nephrectomy. Arch Ital Urol Androl. 2020;92(3). https://doi.org/10.4081/aiua.2020.3.165
6. Kutikov A, Uzzo RG. The R.E.N.A.L. nephrometry score: a comprehensive standardized system for quantitating renal tumor size, location and depth. J Urol. 2009;182(3):844-53. https://doi.org/10.1016/j.juro.2009.05.035
7. Mittakanti HR, Heulitt G, Li HF, Porter JR. Transperitoneal vs. retroperitoneal robotic partial nephrectomy: a matched-paired analysis. World J Urol. 2020;38(5):1093-9. https://doi.org/10.1007/s00345-019-02903-7
8. Socarrás MR, Elbers JR, Rivas JG, Autran AM, Esperto F, Tortolero L, et al. Retroperitoneal robot-assisted partial nephrectomy (rRAPN): surgical technique and review. Curr Urol Rep. 2021;22(6):33. https://doi.org/10.1007/s11934-021-01051-z
9. Eraky A, Hamann C, Harke NN, Tropmann-Frick M, Jünemann KP, Osmonov D. Robot-assisted partial nephrectomy: a single-center matched-pair analysis of the retroperitoneal versus the transperitoneal approach. Turk J Urol. 2021;47(4):305-12. https://doi.org/10.5152/tud.2021.21008
10. Lyu X, Jia Z, Ao L, Ren C, Wu Y, Xu Y, et al. Robot-assisted partial nephrectomy: can retroperitoneal approach suit for renal tumors of all locations?-A large retrospective cohort study. BMC Urol. 2022;22(1):202. https://doi.org/10.1186/s12894-022-01128-y
11. Ricciardulli S, Ding Q, Zhang X, Li H, Tang Y, Yang G, et al. Evaluation of laparoscopic vs robotic partial nephrectomy using the margin, ischemia and complications score system: a retrospective single center analysis. Arch Ital Urol Androl. 2015;87(1):49-55. https://doi.org/10.4081/aiua.2015.1.49

12. Miyake H, Motoyama D, Matsushita Y, Watanabe H, Tamura K, Otsuka A, et al. Initial experience of robot-assisted partial nephrectomy using hinotori surgical robot system: single institutional prospective assessment of perioperative outcomes in 30 cases. J Endourol. 2023;37(5):531-4. https://doi.org/10.1089/end.2022.0775
13. Thompson RH, Lane BR, Lohse CM, Leibovich BC, Fergany A, Frank I, et al. Every minute counts when the renal hilum is clamped during partial nephrectomy. Eur Urol. 2010;58(3):340-5. https://doi.org/10.1016/j.eururo.2010.05.047
14. Ogan K, Jacomides L, Saboorian H, Koeneman K, Li Y, Napper C, et al. Sutureless laparoscopic heminephrectomy using laser tissue soldering. J Endourol. 2003;17(5):295-300. https://doi.org/10.1089/089277903322145468
15. Zhang F, Gao S, Chen XN, Wu B. Clampless and sutureless laparoscopic partial nephrectomy using monopolar coagulation with or without N-butyl-2-cyanoacrylate. World J Surg Oncol. 2019;17(1):72. https://doi.org/10.1186/s12957-019-1614-8
16. Porpiglia F, Bertolo R, Amparore D, Fiori C. Nephron-sparing suture of renal parenchyma after partial nephrectomy: which technique to go for? Some best practices. Eur Urol Focus. 2019;5(4):600-3. https://doi.org/10.1016/j.euf.2017.08.006
17. Carbonara U, Amparore D, Gentile C, Bertolo R, Erdem S, Ingels A, et al. Current strategies to diagnose and manage positive surgical margins and local recurrence after partial nephrectomy. Asian J Urol. 2022;9(3):227-42. https://doi.org/10.1016/j.ajur.2022.06.002