RESEARCH ARTICLE

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Laparoscopic Partial Nephrectomy: Off-Clamp Versus on Clamp

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Abstract

Purpose: The aim of this study is to describe our experience in laparoscopic partial nephrectomy and to compare the differences between off-clamp and on-clamp techniques in terms of clinical characteristics and outcomes. **Methods:** A retrospective study was utilized. A purposeful sampling method was used to select the patients. The inclusion criteria for kidney tumors were as follows: exophytic, maximum diameter 3 cm, RENAL score 4 or more, solid or cystic, and suspected of malignancy. Around 32 participants were selected. The data were collected from patient files. **Results:** There were no statistically significant differences between the mean of the off-clamp group and the on-clamp group in terms of tumor size, size of the kidney, and the position of the tumor. The average expected blood loss in the off-clamp group was 150.15 +/- 60.25 mL and in the on-clamp group was 75.25+/- 40.11 mL, with a p-value of less than 0.001. There was no statistically significant difference between the two groups in terms of the most common surgical complications, postoperative drainage, overall operation time, renorrhaphy time, and postoperative bedtime. **Conclusion:** The off-clamp group was shown to have a higher tumor resection duration as well as a higher rate of expected blood loss. The functional result of alterations in the estimated glomerular filtration rate seemed to be better in the off-clamp group. We expect to understand its long-term safety and oncological efficacy better as we continue to use this method.

Keywords: Partial nephrectomy- Jordan- off clamp- laparoscopic

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Introduction

During the last several decades, the incidence of renal cell carcinoma (RCC) has been rising steadily (Ng et al., 2017; Wang et al., 2016). Radical nephrectomy for localized malignancies is the optimal and common treatment, even though this surgical technique significantly increases the risk of cardiovascular morbidity and mortality risks due to reduced kidney function (Peyronnet et al., 2017; Shah et al., 2016). According to recent research findings, in partial nephrectomy with renal artery clamping, every minute of ischemia increases the chance of developing postoperative renal impairment. The cold ischemia technique may offer more excellent kidney function protection, but it often prolongs the ischemic period, reducing their effectiveness (Anderson et al., 2019; Shah et al., 2016; Wang et al., 2016).

The preoperative aspects and dimensions used for anatomic (PADUA) classification, Radius, exophytic/endophytic, anterior/posterior location (RENAL) score and contact surface area are the anatomy-based nephrometry scoring systems that are selected to guide decisions on radical nephrectomy or nephron-sparing surgery. A novel off-clamp laparoscopic partial nephrectomy technique was used on a small number of patients. This technique was guided by the RENAL score and shown to prevent some of the incidents associated with hilar clamping during laparoscopic partial nephrectomy and renal hilar dissection and to completely prevent renal ischemic injury compared to conventional on-clamp laparoscopic partial nephrectomy (Antonelli, Veccia, et al., 2019; Aquil et al., 2020; Bove et al., 2019).

Trehan (2014) conducted a meta-analysis to compare oncological outcomes, peri- and postoperative variables, surgical complications, and renal outcomes of on-clamp and off-clamp partial nephrectomy. The pooled estimates of the length of stay, positive surgical margins, operative time, transfusion rates, tumor size, overall complications, urinary leaks, estimated blood loss, and estimated glomerular filtration rate, were calculated. The results showed that there was no significant difference between on-clamp and off-clamp partial nephrectomy in terms of transfusion rates, overall complications, operative time, length of stay, urinary leaks, estimated blood loss, tumor

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size, and positive surgical margins. A non-statistically significant trend towards decreased transfusion rates (p = 0.07) and blood loss (p = 0.12) in those undergoing on-clamp was noted (Trehan, 2014).

According to a prospective trial, there was no benefit in maintaining renal function, and off-clamp robot-assisted partial nephrectomy had similar perioperative results as the on-clamp procedure. Depending on the surgeon's inclination and patient-specific circumstances such as baseline numerous masses, renal insufficiency, or solitary kidney, urologists can safely use either an on-clamp or off-clamp method (Anderson et al., 2019).

The variations in the results encourage the authors to describe their experiences in laparoscopic partial nephrectomy and to compare the differences between off-clamp and on-clamp techniques in terms of clinical characteristics and outcomes in a developing country.

Materials and Methods

Design and Setting

A retrospective study was conducted in private clinics in Jordan.

Sample

Between July 2017 and October 2021, A purposeful sampling method was used to select the patients. Thirty-two consecutive patients who underwent transperitoneal laparoscopic partial nephrectomy were reviewed following clearance by the institutional review board. The inclusion criteria for kidney tumors were as follows: exophytic, maximum diameter 3 cm, RENAL score 4 or more, solid or cystic, and suspected of malignancy.

Procedure

All laparoscopic partial nephrectomies were done sequentially, one by one, by the same surgeon. laparoscopic partial nephrectomy was performed on 16 patients using an off-clamp technique, whereas 16 patients got conventional laparoscopic partial nephrectomy. Detailed information about the patients is obtained, including their demographic characteristics; main procedure, and consequences variables, such as total operation time, renal surgery time, preoperative estimated glomerular filtration rate, length of hospital stay, estimated blood loss, resection time, estimated glomerular filtration rate change, 24–48-hour postoperative estimated glomerular filtration rate, and tumor's histological findings (grade, location, side, and size), which were gathered prospectively following the Fuhrman grading method and the 2004 World Health Organization categorization.

General anesthesia was given to the patients, who were then put in the lateral decubitus position. There were three ports implanted. Following establishing the transperitoneal cavity, the kidney was moved as needed to fully expose the tumor. During the procedure, the tumor's depth and diameter were evaluated by intraoperative ultrasonography. Before removing the tumor, the renal artery was dissected and clamped in just 16 of the patients under on-clamp laparoscopic partial nephrectomy treatment. 2 to 3 mm away from the tumor, the renal capsule was opened by Scissors. To remove as much of the tumor as possible, cutting deep into the renal cortex gently and cautiously was conducted. When minor arterial bleeding occurred, bipolar coagulation was used to stop the bleeding. After the tumor had been completely removed, the margin of resection was checked by a frozen section to verify that the tumor had been completely removed from the body. Then, Hem-o-Lok clips were used to strengthen the sutures during renorrhaphy.

Prior to surgery, serum creatinine measures were taken and also after one week of the procedure. The estimated glomerular filtration rate was computed using the modification of diet in the renal disease equation (measured in units of milliliters per minute per square meter of body surface area = ml/min/1.73 m^2).

Data Analysis

SPSS version 21 statistical software (SPSS Inc., Chicago, IL) was conducted to analyze the data. The chi-square test and Pearson correlation coefficients were used to examine categorical and continuous data, respectively. Statistics were deemed statistically significant when p values of 0.05 or less were obtained.

Results

The research included a total of 32 patients (16 laparoscopic partial nephrectomy off-clamp and 16 laparoscopic partial nephrectomy on-clamp) (Table 1). The mean age for the off-clamp group was 58.14 years, whereas the mean age for the on-clamp group was 57.24 years. The mean tumor size was 17.25 mm for the off-clamp group and 18.11 mm for the on-clamp group. There were no statistically significant differences between the mean of the off-clamp group and for the on-clamp group two groups in terms of tumor size, size of the kidney, and the position of the tumor.

All patients had negative surgical margins and did not have any postoperative problems such as delayed bleeding, hematuria, or urine leakage. Any of the instances did not need conversion to either the clamped method or the open technique, and none did. The average EBL in the off-clamp group was 150.15+/-60.25 mL and in the on-clamp group was 75.25+/-40.11 mL, respectively, with a p-value of less than 0.001. See Table 2.

In the off-clamp patients, the tumor resection time was greater than it was in the on-clamp patients (6.81+/- 1.10 min vs 6.21+/- 1.20 min, respectively, p = 0.026). There was no statistically significant difference between the two groups in terms of the most common surgical complications, postoperative drainage, overall operation time, renorrhaphy time, and postoperative bedtime.

Clear-cell RCC (n = 21) , oncocytoma (n = 1), RCC of the chromophobe type (n = 2) and papillary RCC (n = 8) were the common histopathological types studied. Grades assigned by Fuhrman were as follows: grade 1 (n = 5), grade 2 (n = 20), and grade 3 (n = 7).

The mean preoperative serum estimated glomerular filtration rate in the off-clamp group was 88.12 (17.21) ml/min and 87.92 (19.71) ml/min in the on-clamp group,

Table 1. Patients' Preoperative Demographics

Factor	Off-clamp	On-clamp	p value
Gender			
Male	11	13	0.891
Female	5	3	
Main Age (SD)	58.14 (7.1)	57.24 (9.2)	0.981
Height (cm, mean ± SD)	168 (7.14)	169 (5.34)	0.871
Weight (kg, mean ± SD)	72.21 (5.25)	74.21 (2.27)	0.761
Tumor size (mm, mean ± SD)	17.25 (7.25)	18.11 (4.15)	0.512
Side of the kidney			
Left	9	10	0.128
Right	7	6	
Position of tumor			
Upper pole	3	2	0.731
Middle	7	5	
Lower pole	6	9	

respectively, with a p-value of 0.611. The postoperative serum estimated glomerular filtration rate in the off-clamp group were 86.72 (15.31) ml/min and 82.77 (17.21) ml/min in the on-clamp group, respectively, with a p-value of 0.932. Except for the off-clamp group, the mean eGFR changes were -1.40 (1.90) ml/min and -5.15 (2.50) in the on-clamp group, both of which were statistically significant at 0.05 level.

Discussion

Numerous surgeons are turning to minimally invasive nephron-saving surgery because it provides excellent oncologic outcomes and preserves renal function. It has always been a challenge in kidney cancers treatment to figure out how to keep the kidneys functioning as much as possible. The use of other methods, such as microwave energy, super selective embolization, renal parenchymal clamping, segmental renal artery clamping, selective renal artery clamping, cold ischemia, radiofrequency energy, laser, and hydro-jet, has yielded some advantages, but each of them has the set of drawbacks and shortcomings (Antonelli, Cindolo, et al., 2019; Antonelli, Veccia, et al., 2019; Bertolo et al., 2019). In terms of renal function preservation at the end of the first year after surgery, transperitoneal and retroperitoneal access were shown to have equal results. In patients with non-complex renal malignancies, off- clamp may be a safe and effective therapy option (Mercimek & Ozden, 2020)

A total of five anatomic radiologic properties make up the RENAL nephelometry score: (R)adius/maximal tumor diameter, (E)xophytic/endophytic properties, (N) earness to the collecting system or sinus, (A)nterior(a)/

Table 2. Postoperative Characteristics

Factor	Off-clamp	On-clamp	p value
Subtypes			
Clear cell	11	10	0.421
Papillary	4	4	
Chromophobe	1	1	
Oncocytoma	0	1	
Grade			
1	3	2	0.431
2	10	10	
3	3	4	
Resection time(min, mean ± SD)	6.81 ± 1.10	6.21 ± 1.20	0.026
Renorrhaphy time (min, mean ± SD)	17.12± 3.27	15.17± 4.27	0.17
Estimated blood loss (ml, mean ± SD)	150.15± 60.25	75.25± 40.11	0.001
Drainage (ml, mean ± SD)	210.12± 80.25	160.17± 70.75	0.052
Operation time (min, mean ± SD)	78.72± 15.78	89.42± 14.58	0.162
Postoperative bedtime (day, mean ± SD)	4.21± 2.21	4.17± 1.71	0.896
estimated glomerular filtration rate pre-operation (ml/min/1.73 m^2 , mean ± SD)	88.12± 17.21	87.92± 19.71	0.611
Estimated glomerular filtration rate post-operation (ml/min/1.73 m^2 , mean ± SD)	86.72± 15.31	82.77± 17.21	0.932
Estimated glomerular filtration rate change (ml/min/1.73 m2 , mean ± SD) –	-1.40±1.90	-5.15±2.50	<0.001
Hematuria	0	0	1
Postoperative hemorrhage	0	0	1
Blood transfusion	0	0	1
Urinary leakage	0	0	1
Clavien-Dindo classification of surgical complications			
Grades 1–2	16	16	1
Grades 3–5	0	0	

posterior(p)/not anterior or posterior (x) descriptor, and (L)ocation relative to the polar line. There are 1 to 3 points given for each variable, with the exception of A. This results in a total of 12 points for the most complex mass and 4 points for the least. High complexity masses (scores 10–12), moderate complexity masses (scores 7–9), Low complexity masses (RENAL scores 4–6) are all categorized as such (Antonelli, Veccia, et al., 2019; Atis et al., 2020; Peyronnet et al., 2017).

For off-clamp intraperitoneal laparoscopic partial nephrectomy, tumors with a maximum diameter of less than 3 cm and a RENAL score of 4 are selected in this study since they had the least complex and have the fewest surgical consequences, such as hemorrhage, urine leakage, renal pelvis damage, and hematuria

Off-clamp partial nephrectomy may decrease the risk of chronic and acute renal damage in patients with hypertension (Bertolo et al., 2019; Peyronnet et al., 2017).. Our findings showed that off-clamp was secure in those carefully chosen patients, with a little increase in bleeding. However, it improved kidney function. The risk of ischemia was low; therefore this was acceptable. When we are taking the tumor and suturing the kidney incision, we briefly elevate the pneumoperitoneum pressure to 18 mmHg in the operating room. For off-clamp laparoscopic partial nephrectomy, we anticipate that this technique will help to reduce blood loss.

Maintaining renal function offered no advantage, and off-clamp robot-assisted partial nephrectomy had the same perioperative outcomes as the on-clamp treatment. Urologists may safely utilize either an on-clamp or an off-clamp approach, depending on the surgeon's preference and patient-specific conditions such as baseline many masses, renal insufficiency, or a solitary kidney (Anderson et al., 2019).

When compared to on-clamp partial nephrectomy, off-clamp partial nephrectomy may be linked with better long-term renal results, with no differences in surgical complications, peri- and postoperative factors, or oncological outcomes (Trehan, 2014).

Preplacing sutures sequentially, as opposed to simple excision without hilar clamping, helps in giving improved visibility as a result of a reduction in bleeding into the tumor bed. As a result, we may try to include this treatment into the zero-ischemia laparoscopic partial nephrectomy under robotic surgery. In addition, postoperative drainage was higher in the off-clamp group with no statistical significance. When removing the tumor, we utilized cold scissors and suction to ensure that it was completely resected and that we did not cut into the tumor, which was important in a constant bleeding condition.

When used in an off-clamp zero ischemia scenario with continuous bleeding, energy-saving devices such as the HARMONIC ACE+7 shears, ultrasonic knife, high-frequency electrosurgical equipment, and Valley Force Triad energy platform were shown to be insufficient for tumor removal. Coagulation was poor, and there was a lot of eschars, that rendered the plane blurry and unclear, making it impossible to do a complete resection. It was successful in limiting minor artery hemorrhage using bipolar coagulation, However, it was a problem to control a wide region of venous bleeding from the tumor bed (Bertolo et al., 2019; Bove et al., 2019; Peyronnet et al., 2017; Shah et al., 2016).

Suturing is still the most effective technique of controlling venous hemorrhage. The kidney tissue was more breakable in the absence of a clamp, and it was more susceptible to being ripped while suturing. In renorrhaphy, we used Polysorb braided absorbable suture 1 because it was thick sufficient to prevent trimming into normal kidney tissue while still stiff adequately to draw the separate incision back concurrently (Antonelli, Cindolo, et al., 2019; Rosen et al., 2017; Shah et al., 2016).Because they are excessively harsh and increase the likelihood of bleeding at the site of the needle insertion, Barbed sutures are not advised.

One drawback of our approach is that it can only be used for tumors with a low RENAL score. Robotic surgery may be beneficial in those cases because it allows for better tumor excision and renorrhaphy (Antonelli, Cindolo, et al., 2019; Rosen et al., 2017).

Another drawback of the present research is the limited sample size and the fact that the effects are only of brief duration. A larger cohort of participants and long-term follow-up, particularly in terms of estimated glomerular filtration rate change over 12 months, is needed for external validation of these findings.

In conclusion, in laparoscopic partial nephrectomy, we investigated the differences between main artery clamping and off-clamping. The off-clamping group was shown to have a higher tumor resection duration as well as a higher rate of expected blood loss. The functional result of alterations in eGFR seemed to be better in the off-clamping group. As we continue to use this method, we expect to better understand its long-term safety and oncological efficacy.

Author Contribution Statement

The authors confirm that the authors actively participated in study conception and design, data collection, analysis, interpretation of results, and draft manuscript preparation processes. All authors reviewed the results and approved the final version of the manuscript.

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Study Implication

The results describe our experience in laparoscopic partial nephrectomy and compared the differences between off-clamp and on-clamp techniques in terms of clinical characteristics and outcomes. This helps the health professionals to make a proper decision regarding their patients.

Scientific and Ethical Approval

The proposal of the study was reviewed and approved by Ethical approval was obtained from the research office at Mutah University, Karak, Jordan. This Approval has confirmed the confidentiality and privacy of participant information.

Availability of data

The data is available upon the request

Conflict of Interest

The authors have no conflicts of interest to disclose.

References

Anderson BG, Potretzke AM, Du K, et al (2019). Comparing Off-clamp and On-clamp Robot-assisted Partial Nephrectomy: A Prospective Randomized Trial. *Urology*, **126**, 102–9.

Antonelli A, Veccia A, Francavilla S, et al (2019). On-clamp versus off-clamp robotic partial nephrectomy: A systematic review and meta-analysis. *Urologia*, **86**, 52–62.

Aquil S, Olvera-Posada D, Navaratnam R, et al (2020). Comparative Study Assessing Postoperative Renal Loss Using Two Different Partial Nephrectomy Techniques: Off-Clamp versus Standard On-Clamp Surgery. *Curr Urol*, **14**, 38–43.

Atis G, Culpan M, Ucar T, et al (2020). The effect of shock wave lithotripsy and retrograde intrarenal surgery on health-related quality of life in 10–20 mm renal stones: a prospective randomized pilot study. *Urolithiasis*, **2020**, 1–7.

Bertolo R, Simone G, Garisto J, et al (2019). Off-clamp vs on-clamp robotic partial nephrectomy: Perioperative, functional and oncological outcomes from a propensity-score matching between two high-volume centers. *J Surg Oncol*, **45**, 1232–7.

Bove P, Bertolo R, Sandri M (2019). Assessing the impact of renal artery clamping during laparoscopic partial nephrectomy for small renal masses: the rationale and design of the CLamp vs Off Clamp Kidney during LPN (CLOCK II) randomised phase III trial. *BJU Int*, **124**, 365–7.

Deng W, Liu X, Hu J, et al (2018). Off-clamp partial nephrectomy has a positive impact on short- and long-term renal function: A systematic review and meta-analysis. *BMC Nephrol*, **19**, 1–10.

Mercimek MN, Ozden E (2020). Comparison of functional outcomes of off-clamp laparoscopic partial nephrectomy access techniques: A preliminary report. *Int Braz J Urol*, **47**, 103–11.

Ng AM, Shah PH, Kavoussi LR (2017). Laparoscopic Partial Nephrectomy: A Narrative Review and Comparison with Open and Robotic Partial Nephrectomy. Https://Home. Liebertpub.Com/End, 31, 976–984. https://doi.org/10.1089/END.2017.0063.

Peyronnet B, Khene ZE, Pradère B, et al (2017). Off-Clamp versus On-Clamp Robotic Partial Nephrectomy: A Multicenter Match-Paired Case-Control Study. *Urol Int*, **99**, 272–6.

Rosen DC, Paulucci DJ, Abaza R (2017). Is Off Clamp Always Beneficial During Robotic Partial Nephrectomy? A Propensity Score-Matched Comparison of Clamp Technique in Patients with Two Kidneys. *Endourol*, **31**, 1176–82.

Shah PH, George AK, Moreira DM, et al (2016). To clamp or not to clamp? Long-term functional outcomes for elective off-clamp laparoscopic partial nephrectomy. *BJU Int*, **117**, 293–9.

Trehan A (2014). Comparison of Off-Clamp Partial Nephrectomy and On-Clamp Partial Nephrectomy: A Systematic Review and Meta-Analysis. *Urol Int,* **93**, 125–34.

Wang HK, Qin XJ, Ma CG, et al (2016). Nephrometry score-guided off-clamp laparoscopic partial nephrectomy: Patient selection and short-time functional results. *World J Surg Oncol*, **14**, 1–6.