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Comparison of Laparoscopic and Open Partial Nephrectomy in Early-Stage Kidney Masses

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What's known on the subject? and What does the study add?

Partial nephrectomy is preferred in early-stage renal tumors because it provides oncological outcomes similar to radical surgery while preserving kidney function. In this study, we aimed to demonstrate the impact of the choice between open and laparoscopic surgery on perioperative and postoperative parameters, as well as long-term effects, in partial nephrectomy procedures performed in our clinic.

Abstract

Objective: The aim of this study was to demonstrate our clinical experience on the impact of the choice between open partial nephrectomy (OPN) and laparoscopic partial nephrectomy (LPN) on achieving optimal oncological outcomes, perioperative parameters, postoperative recovery and patient comfort, and long-term kidney function in patients undergoing these surgical methods.

Materials and Methods: Data from 127 patients who underwent partial nephrectomy between December 2020 and March 2024 were retrospectively reviewed, with 47 patients in the LPN group and 80 in the OPN group. The patients' demographic information, tumor sizes, complications, and perioperative and postoperative data were compared.

Results: It was found that patients undergoing OPN had larger tumor sizes and higher PADUA scores compared to the LPN group ($p<0.001$ and $p=0.011$, respectively). LPN showed an advantage in terms of lower average blood loss ($p<0.001$), while OPN was advantageous in terms of shorter warm ischemia time ($p=0.001$). Patients in the LPN group had shorter hospital stays and required fewer transfusions ($p<0.001$ and $p=0.021$, respectively). When complications and pathology results were evaluated, outcomes were similar in both groups. The decrease in glomerular filtration rate was found to be less in the LPN group compared to the OPN group ($p=0.008$).

Conclusion: LPN offers advantages over OPN, including less perioperative bleeding, lower morbidity, and shorter hospital stays. However, the longer warm ischemia time in LPN should be considered alongside these benefits.

Keywords: Pathology, radiology, urooncology

Introduction

Radical nephrectomy has long been considered the gold standard in the treatment of renal cell carcinoma. However, the emergence of minimally invasive approaches such as conservative treatments active surveillance, partial nephrectomy, and ablation techniques (cryotherapy, radiofrequency ablation) has gained prominence, especially for small masses, and due to the increased morbidity associated with radical surgery (1). It has been shown that partial nephrectomy, when applied to patients with stage T1 and appropriately located stage T2 tumors, provides similar oncological outcomes to radical nephrectomy while better preserving kidney function and reducing the risk of postoperative cardiovascular events (2). When evaluating the suitability for partial nephrectomy, the size, location, depth of the tumor, and its proximity to the hilum and collecting system, are considered. The surgical approaches for partial nephrectomy (open, laparoscopic, or robotic) depend

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on the tumor characteristics, as well as the surgeon's expertise and experience.

Laparoscopic partial nephrectomy (LPN) is considered to offer certain advantages over traditional open partial nephrectomy (OPN) in terms of oncological and surgical principles for kidney tumors. Studies have demonstrated that this method offers similar oncological efficacy and superior renal functional outcomes compared to laparoscopic radical nephrectomy. The main advantages of LPN include reduced blood loss, less postoperative pain, quicker postoperative recovery, better cosmetic outcomes, and more nephron-sparing results compared to other methods (3).

In this study, we reviewed the data of patients who underwent partial nephrectomy through either open or laparoscopic approaches in our clinic, aiming to evaluate the impact of the surgical method for achieving optimal oncological outcomes, perioperative parameters, postoperative patient comfort, and long-term kidney function.

Materials and Methods

Prior to the study, approval was obtained from the Marmara University Clinical Research Ethics Committee with protocol number 09.2023.554 and dated 30.05.2023. Data from 156 patients who presented with kidney masses to the Urology clinic of Marmara University Hospital between December 2020 and March 2024 and underwent either OPN or LPN by experienced surgeons according to the indications in the European Association of Urology Guidelines were retrospectively reviewed. Of the 156 patients, 29 were excluded due to preoperative chronic kidney disease, solitary kidney, multiple or bilateral tumors, metastatic disease, or loss of follow-up. A total of 80 patients who underwent OPN and 47 patients who underwent LPN were included in the study.

OPN was performed retroperitoneally. The laparoscopic procedure was performed transperitoneally. In all patients, two-layer renorrhaphy was performed after tumor excision. 2-0 and 3-0 V-Loc sutures were used for the renorrhaphies.

The preoperative demographic information of the patients, including age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, and Charlson comorbidity index (CCI) score, was recorded. For kidney mass evaluation, tumor size, tumor side, RENAL nephrometry score, and PADUA score were used. To compare surgical methods, perioperative parameters such as blood loss, operative time, warm ischemia time, perioperative transfusion requirements, and perioperative complications were recorded. Postoperative parameters included length of hospital stay, postoperative transfusion requirements, and postoperative complications. Postoperative complications were identified within 30 days after the surgery, and the Clavien-Dindo classification was used for complication assessment. For kidney function evaluation, preoperative and postoperative (3rd month), estimated glomerular filtration rate (eGFR), hemoglobin (Hgb), and hematocrit (Hct) values were used. The modified diet in renal disease formula was employed to calculate the eGFR. Pathology results of the patients' surgical specimens and rates of positive surgical margins were also recorded.

Statistical Analyses

Statistical analysis was conducted using IBM SPSS version 25.0. The Shapiro-Wilk test was initially applied to test the normality of the distribution between patients. Since the data did not show normal distribution, non-parametric methods were used. Nominal data were presented in tables as numbers and percentages, while numerical data were presented as medians, minimum, and maximum values. The comparison of the OPN and LPN groups was performed using the chi-square or Fisher's exact test for nominal data. The Mann-Whitney U test was used for the statistical analysis of numerical data, as the assumption of normality was not met. A p-value of 0.05 was considered statistically significant.

Results

A total of 80 patients who underwent OPN and 47 patients who underwent LPN were included in the study. The two groups were initially compared in terms of demographic information and tumor characteristics. There was no significant difference between the groups regarding age, gender, BMI, ASA score, CCI, side, and RENAL nephrometry score. When comparing the tumor size between the two groups, the median value in the OPN group was 37 mm (12-110 mm), while in the LPN group, it was 22 mm (10-68 mm) ($p<0.001$). When comparing the PADUA score, the OPN group scored 7 (5-12) and the LPN group scored 6 (5-9) ($p=0.011$) (Table 1).

Additionally, perioperative data were compared. The median blood loss in the OPN group was 600 mL (50-3300 mL), while in the LPN group, it was 200 mL (50-3200 mL). Blood loss was significantly lower in the LPN group ($p<0.001$). In terms of warm ischemia time, the OPN group had a median ischemia time of 23 minutes (5-40 minutes), whereas the LPN group had 34.5 minutes (18-66 minutes). The ischemia time was significantly lower in the OPN group ($p=0.001$). In contrast, although the operative time was longer in the LPN group, no significant difference was observed ($p=0.663$). Regarding perioperative transfusion requirements, 17 patients (21.25%) in the OPN group and 4 patients (8.51%) in the LPN group required transfusion ($p=0.062$) (Figure 1).

Figure 1. Perioperative parameters

LPN: Laparoscopic partial nephrectomy, OPN: Open partial nephrectomy

Table 1. Demographic information and tumor characteristics

	OPN (n=80)	LPN (n=47)	p-value
Age (years) median (min-max)	57.5 (31-86)	61 (24-78)	>0.05
Sex n (%)			
Men	53 (66.25%)	26 (55.31%)	>0.05
Women	27 (33.75%)	21 (44.69%)	
BMI (kg/m^2) median (min-max)	29.23 (20.52-44.92)	28.12 (21.56-43.6)	>0.05
ASA score median (min-max)	1 (1-3)	2 (1-3)	>0.05
CCI median (min-max)	3 (2-9)	3 (2-7)	>0.05
Side n (%)			
Right	39 (48.75%)	27 (57.44%)	>0.05
Left	41 (51.25%)	20 (42.56%)	
Tumor size (mm) median (min-max)	37 (12-110)	22 (10-68)	**<0.001**
RENAL score median (min-max)	5 (4-11)	5 (4-9)	>0.05
PADAU score median (min-max)	**7** (5-12)	6 (5-9)	**<0.05**

OPN: Open partial nephrectomy, LPN: Laparoscopic partial nephrectomy , BMI: Body mass index, CCI: Charlson comorbidity index, min: Minimum, max: Maximum

When postoperative complications were evaluated, patients in the OPN group had a median hospital stay of 5 days, (3-27 days), while patients in the LPN group had a stay of 4 days, (2-16 days) (p=0.001). In terms of postoperative transfusion rates, 15 patients (18.75%) in the OPN group and 2 patients (4.3%) in the LPN group required transfusion (p=0.021). Although significant differences were found in the length of hospital stay and postoperative transfusion requirements, no statistically significant difference was found in postoperative complications (p=0.358) (Table 2).

The groups were then compared based on pathological results. There was no significant difference when comparing the pathology results based on malignant or benign status and

Table 2. Postoperative comparison and complications			
	OPN (n=80)	**LPN (n=47)**	**p-value**
Duration of hospital stay (days) median (min-max)	5 (3-27)	4 (2-16)	**<0.001**
Transfusion n (%)	15 (18.75%)	2 (4.25%)	**<0.05**
Complications n (%)	16 (20%)	6 (12.76%)	>0.05
Minor complications[a]			
Fever	6	1	
Deep vein thrombosis	3	1	
Hematoma	0	1	
Pulmonary embolism	1	0	
Pleural effusion	2	0	
Drainage increase	2	0	
Hepatitis	1	0	
Hematuria	0	1	
Fat necrosis	1	0	
Major complications[b]			
Ex	0	2	

OPN: Open partial nephrectomy, LPN: Laparoscopic partial nephrectomy, min: Minimum, max: Maximum
[a]: Clavien-Dindo 1,2
[b]: Clavien-Dindo 3,4,5

Table 3. Pathology results			
	OPN (n=80)	**LPN (n=47)**	**p-value**
Surgical margin positivity n (%)	0	2 (4.25%)	>0.05
Pathology result n (%)			>0.05
Malignant			
Clear cell carcinoma	50 (62.5%)	28 (59.57%)	
Papillary carcinoma	5 (6.25%)	2 (4.25%)	
Chromophobic cell carcinoma	9 (11.25%)	5 (10.63%)	
Benign	15 (18.75%)	12 (25.53%)	

OPN: Open partial nephrectomy, LPN: Laparoscopic partial nephrectomy

subtypes (p=0.661) (Table 3). No recurrence was observed during the long-term follow-up of the patients. When the pathology data of the patients included in the study were reviewed, the results showed that the outcome was benign in 27 out of 127 patients, and malignant in 100 patients. Among these 100 patients, 2 had positive surgical margins. No patient in the OPN group had a positive surgical margin, while 2 patients (4.25%) in the LPN group had positive margins (p=0.133). In the follow-up of these 2 patients, no recurrence was observed in the long term. These 2 patients were closely monitored. However, during the one-year oncological follow-up, no recurrent masses were detected in either the patients with positive surgical margins or those with other malignant pathologies.

Finally, the groups were analyzed in terms of preoperative, postoperative GFR at 3 months GFR, Hgb, and Hct values, as well as the changes in these values. There was no significant difference between the OPN and LPN groups in terms of preoperative GFR, Hgb, Hct, postoperative GFR, Hgb, Hct, or changes in Hgb and Hct. However, when comparing the GFR change between the groups, the GFR in the OPN group was -11.76 (-68.36 to -32.78) mL/min/1.73 m², while in the LPN group, it was -2.6 (-59.18 to -29.37) mL/min/1.73 m². A statistically significant difference was found between the two groups (p=0.008) (Table 4).

Discussion

With recent advancements in surgical techniques, partial nephrectomy, a minimally invasive procedure, has become the preferred primary method for treating clinical stage T1 renal masses. Studies have shown that there is no difference in cancer-specific survival between partial nephrectomy and radical nephrectomy in terms of oncological control (4-7).

In our study, the demographic data, preoperative, perioperative, and postoperative outcomes of patients who underwent

partial nephrectomy using either laparoscopic or open methods were evaluated. No difference was observed between the two groups in terms of demographic data. The four most commonly used scoring systems for surgical planning are the C-index, RENAL score, PADUA score, and D.A.P score (8). The RENAL score has the best correlation with surgical outcomes (9). When preoperative data were examined, it was found that the tumor size and PADUA score of patients who underwent OPN were higher than the LPN group. When comparing perioperative data, LPN was advantageous with lower average blood loss, while OPN offered shorter warm ischemia time. Although not statistically significant, OPN had a shorter operative time. Postoperatively, it was found that patients in the LPN group had a shorter hospital stay and required fewer transfusions. The complications and pathology results were similar in both groups. In terms of kidney function assessment, the decrease in GFR change values, obtained by subtracting the preoperative GFR value from the GFR recorded at 3 months postoperatively, was lower in the LPN group, compared to the OPN group. There was no difference between preoperative and postoperative GFR, Hgb, and Hctvalues. No difference was observed between the two methods in terms of Hgb and Hct changes.

Schiff et al. (10) found that, similar to our study, the average tumor size was higher in the OPN group compared to the LPN group when looking at the literature. The tendency towards open surgery in patients with larger tumor sizes could explain this.

In contrast to our study, Beasley et al. (11) suggested that OPN and LPN caused similar amounts of blood loss. Similar to our findings, Schiff et al. (10) found that, blood loss was lower in the LPN group, although not statistically significant.

Warm ischemia time is one of the factors affecting the preservation of kidney function and is one of the goals of partial nephrectomy. In our study, we found that the warm ischemia time was significantly longer in the LPN group. Similarly, a study conducted by Gill et al. (12) involving 1800 patients found that warm ischemia time was significantly longer in the LPN group than in the OPN group. A study by Porpiglia et al. (13) showed that a warm ischemia time of >30 minutes increased kidney damage. Therefore, we have concluded that we need to reduce the warm ischemia time in LPN surgeries.

In the literature, there are studies showing that the operation times are similar in both surgical methods (14,15). the study by Beasley et al. (11) found that the operative times of patients who underwent LPN were significantly longer. Although not statistically significant, we found that LPN took longer in our study. Conversely, there are studies in the literature that show LPN takes less time (10,12). These differences may be influenced by the level of surgical experience.

In our study, although the warm ischaemia period and operation time were shorter in OPN, the transfusion requirement was higher in this group compared to the laparoscopic group, likely due to increased bleeding inherent in the open surgical method.

When comparing hospital stay durations, Beasley et al. (11), similar to our study, showed that hospital stays were shorter in the LPN group.

In the literature, there are many studies comparing LPN and OPN in terms of complication rates. Similar to our study, Beasley et al. (11) showed that both OPN and LPN could be performed with similar complication rates. Contrary to our results, there are also publications, such as the study by Gill et al. (14), showing that the complication rates in laparoscopic procedures are higher.

When creatinine measurements were made between the groups to assess postoperative kidney function, Schiff et al. (10) found no difference in their study. In our study, we found that the decrease in GFR was significantly higher in the OPN group

Table 4. Evaluation of kidney functions

	OPN (n=80)	LPN (n=47)	p-value
Preoperative GFR (mL/min/1.73 m²) median (min-max)	92.29 (33.06-187.04)	87.98 (46.11-154.1)	>0.05
Postoperative GFR (ml/min/1.73 m²) median (min-max)	86.47 (11.72-151.25)	83.34 (39.23-130.83)	>0.05
ΔGFR (ml/min/1.73 m²) median (min-max)	-11.76 (-68.36-32.78)	-2.6 (-59.18-29.37)	**<0.05**
Preoperative Hgb (g/dL) median (min-max)	14 (10-17.7)	13.85 (10.4-18.4)	>0.05
Postoperative Hgb (g/dL) median (min-max)	13.55 (8.9-16.6)	13.25 (9.8-17.3)	>0.05
ΔHgb (g/dL) median (min-max)	-0.4 (-5.3-3)	-0.5 (-3.6-1.3)	>0.05
Preoperative Htc (%) median (min-max)	42 (30.8-50.8)	42.85 (33.6-56.8)	>0.05
Postoperative Htc (%) median (min-max)	39.7 (25.7-49.4)	40-8 (31.6-54.3)	>0.05
ΔHtc (%) median (min-max)	-1 (-17.2-6.9)	-0.95 (-9.2-5.7)	>0.05

OPN: Open partial nephrectomy, LPN: Laparoscopic partial nephrectomy, GFR: Glomerular filtration rate, Hgb: Hemoglobin, Htc: Hematocrit, min: Minimum, max: Maximum

compared to the LPN group, while there was no significant difference between preoperative and postoperative creatinine values. Considering this result, OPN is suggested to be more disadvantageous than LPN in terms of preserving kidney function.

Additionally, considering that the procedure was performed using a retroperitoneal approach in the OPN patients and a transperitoneal approach in the LPN patients, the OPN method provides both a lower risk of bowel injury and a reduced risk of postoperative ileus. None of our patients developed ileus.

Study Limitations

When evaluating the limitations of the study, its retrospective nature is a major limitation. Including a cost analysis in the comparison of these two methods would provide a more accurate assessment. The differences in tumor size and PADUA scores between patients who underwent partial nephrectomy via open and laparoscopic methods also constitute a limitation, as they may have an impact on surgical outcomes. Additionally, having all surgeries performed by a single surgeon could help obtain more homogeneous data. Higher-level evidence could be obtained from future prospective, double-blind, randomized studies.

Conclusion

LPN, when compared to OPN, provides similar oncological outcomes while offering less perioperative bleeding, lower morbidity, and shorter hospital stays. Although LPN should be prioritized and encouraged over OPN, performing this procedure in experienced centers, considering the longer warm ischemia time, would be more appropriate for the long-term preservation of kidney function.

Ethics

Ethics Committee Approval: Prior to the study, approval was obtained from the Marmara University Clinical Research Ethics Committee with protocol number 09.2023.554 and dated 30.05.2023.

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Y.T., I.T., Y.S., T.E.S., Concept: T.E.S., Design T.E.S., Data Collection or Processing: T.A., M.Y.S., M.U.K., Analysis or Interpretation: T.A., Literature Search: T.A., Writing: T.A., T.E.S.

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