Original Article

DOI: 10.4274/uob.galenos.2020.1772

Bull Urooncol 2020;19:130-135

Experiences of Laparoscopic Partial Nephrectomy for T1a Kidney Tumours: Results of Two Hundred and Fifteen Patients

Önder Çinar[1], Mustafa Suat Bolat[2], Mehmet Çağatay Çiçek[3], Çağdaş Gökhun Özmerdiven[4], Berna Aytaç Vuruşkan[5], Hakan Vuruşkan[3]

[1] *Zonguldak Bülent Ecevit University, Health Application and Research Center, Department of Urology, Zonguldak, Turkey*
[2] *Samsun Gazi State Hospital, Clinic of Urology, Samsun, Turkey*
[3] *Bursa Uludağ University Faculty of Medicine, Department of Urology, Bursa, Turkey*
[4] *İstanbul Aydın University Faculty of Medicine, Department of Urology, İstanbul, Turkey*
[5] *Bursa Uludağ University Faculty of Medicine, Department of Pathology, Bursa, Turkey*

Abstract

Objective: The best therapeutic option for renal tumours smaller than 7 cm is partial nephrectomy. The aim of this study was to compare the positive surgical margin (PSM) rates, recurrence rates and oncological outcomes between laparoscopic partial nephrectomies and open partial nephrectomies at a single tertiary referral centre.

Materials and Methods: We included patients with renal tumours treated with partial nephrectomies between January 2008 and December 2016 in the study. We retrospectively reviewed the patients' demographic data, surgical reports, clinical charts, laboratory results and histopathological reports. Binary regression analysis was used to assess the impact of the tumour diameter, laterality, polarity and localization for PSM.

Results: We included a total of 215 patients in the study. The mean preoperative and postoperative haemoglobin and creatinine levels, blood loss, time of surgery and follow-up periods was similar between the two groups. The mean ischaemic time in the open partial nephrectomy group was significantly lower than that of the laparoscopic partial nephrectomy group ($p<0.05$). Local recurrence was seen in a patient with a PSM in the laparoscopic partial nephrectomy group. However, recurrences were also seen in the negative surgical margin patients in both the open partial nephrectomy and laparoscopic partial nephrectomy groups.

Conclusion: The presence of a PSM is not associated with an increased risk of distant metastases or local recurrences. However, higher PSM rates were associated with the early learning curve for a laparoscopic procedure. Finally, an open partial nephrectomy is associated with shorter warm ischaemia time compared to laparoscopic partial nephrectomy group.

Keywords: Distant metastasis, kidney tumour, local recurrence, partial nephrectomy, surgical margin positivity

Introduction

The best therapeutic option for localized renal tumours is surgical removal amongst other therapeutic options (1). As a standard treatment option, a partial nephrectomy (PN) provides better oncological and functional results for T1 renal tumours (≤7 cm); with the advantage of healthy renal parenchyma preservation (1,2). An open PN (OPN) has been a safe technique for many years, with high cancer-free survival rates, a better quality of life results, and low local recurrence rates (3). Due to, OPN technique requires longer hospitalisation rates, the need for longer surgical incisions, higher analgesic requirements and an increased comorbidity rate, minimally invasive techniques have become more popular. Advancements in minimally invasive procedures have increased the potential for laparoscopic and robot-assisted PNs, increasing the number of nephron sparing surgeries for T1 tumours. The evolution of imaging techniques (4) have led to the diagnosis of asymtomatic renal masses (up to 27%), with an risk of residual tumours (0.1%-10.7%) (5,6). The surgical technique applied, the skill of the surgeon, and tumour characteristics, such as the location, stage, and grade determines the recurrence rate of the tumour (5,7). No matter the technique, the main goal of a successful tumour management is to remove the renal tumour completely, with lower warm ischaemia times (WITs) (8) and minimal postoperative complication rates (9).

Cite this article as: Çinar Ö, Bolat MS, Çiçek MÇ, Özmerdiven ÇG, Vuruşkan AV, Vuruşkan H. Experiences of Laparoscopic Partial Nephrectomy for T1a Kidney Tumours: Results of Two Hundred and Fifteen Patients. Bull Urooncol 2020;19(3):130-135

Address for Correspondence: Önder Çinar, Zonguldak Bülent Ecevit University, Health Application and Research Center, Department of Urology, Zonguldak, Turkey
Phone: +90 505 950 43 11 **E-mail:** drondercinar@gmail.com **ORCID-ID:** orcid.org/0000-0002-0107-5843
Received: 08.06.2020 **Accepted:** 30.06.2020

In this study, the positive surgical margin (PSM) rates mean ischaemic times, perioperative complication rates, and associated risk factors were compared between OPNs and laparoscopic partial nephrectomies (LPNs) in patients undergoing PNs for kidney tumours.

Materials and Methods

After obtaining Institutional Board Approval from the Clinical Research and Ethics Committee of Zonguldak Bülent Ecevit University (Zonguldak, Turkey) (approval number: 2019-94-12/06, date: 12.06.2019). We then retrospectively reviewed the data of 315 patients with kidney tumours who had undergone LPNs or OPNs, done in a high volume experienced centre between January 2008 and December 2016. We excluded patients with bilateral kidney tumours (n=16) and with a less than two year follow-up (n=14) from the study. Seventy patients with tumours higher than 7 cm, with lymph nodes or distant metastases, and with a history of PNs for benign diseases of the kidney were also excluded from the study.

Finally, the preoperative and postoperative data from 215 patients with complete data were evaluated. The demographic, surgical reports, clinical charts, laboratory results and histopathological reports were reviewed. In addition, detailed medical histories and physical examination findings were obtained in all of the cases.

Patients with T1 kidney tumours were divided into two groups according to the applied surgical technique: an OPN group (group 1, n=46) and an LPN group (group 2, n=169). We assessed the recurrence using radiological methods and additional histopathological examinations where needed. The cancer recurrences were clinically or radiologically assessed in both groups. The presence of a contralateral non-functional kidney or the presence of a tumour in an anatomically solitary kidney was accepted as imperative indications for a PN. The LPN criteria were based on the computed tomography (CT) findings, including the size, localization, and accessibility of the mass, in addition to the general health status and comorbidities of the patient.

Surgical Procedure

The LPN procedure was performed transperitoneally with the patient in a lateral decubitus position. A 12 mm optical camera port was inserted 5 cm lateral at the level of the umbilicus after the pneumoperitoneum was created using a Veress needle. The 10 mm subxiphoidal trocar and 5 mm trocar were placed approximately 2 cm medially and superior to the anterior superior iliac crest to create a triangularly shape under direct vision. For tumours on the right side, an additional 5 mm port was used to retract the liver. The colon was then mobilised medially, and the renal vascular pedicle was exposed. The main renal artery was clamped using a bulldog clamp and the tumour was resected within a safe margin, and put into an endo bag. The renal parenchyma was sutured using 2-0 monofilament poliglecaprone (Monocryl®, Ethicon) sutures in a running manner.

For the OPN, a flank incision was made in patients with lower pole kidney tumours. A subcostal approach was used for those who had upper pole or middle tumours. The renal artery was clamped and the resection of the tumour with the surrounding normal parenchyma was completed and figure eight knots were used for closing the collecting system and the renorrhaphy.

The follow-up protocol was defined as follows:

1. Complete physical examinations and serum creatinine measurements were done at the postoperative first, third and twelfth months and annually thereafter.

2. Plain chest X-rays and CT scans of the abdomen were obtained in the sixth postoperative month and annually after that.

Histopathological Investigation

All the PN specimens were evaluated by the same pathologist. Tumour grading and pathological staging were done according to the Fuhrman et al. (10) nuclear grading system and the 2016 World Health Organization classification (11). The presence of malignant cells at the surgical margin was defined as surgical margin positivity.

Statistical Analysis

The demographic variables, including age, gender and indication for surgery, laterality, diameter and location of the tumour was assessed. The mean follow-up periods, histopathological diagnoses, tumour grades and recurrence rates of the groups were compared using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). An Independent Sample t-test and chi-squared test was used to compare the variables and ratios between the two groups. A p value of less than 0.05 was considered statistically significant. Binary regression analysis was performed to assess the impact of the tumor diameter, laterality, polarity and localization for PSM.

Results

The demographic and clinical characteristics of the LPN and OPN groups, including the age, body mass index, gender, glomerular filtration rate, American Society of Anaesthesiologists score, and comorbidity, presence of surgical margin positivity, tumour location and diameter are given in Table 1. The mean preoperative and postoperative haemoglobin, blood loss, and creatinine levels and the mean surgical time and follow-up periods were similar between the groups ($p>0.05$). The mean warm ischaemia time in the OPN group was significantly lower when compared to the LPN group ($p<0.05$). Other variables, such as the recurrence rate and the clinical and histopathological findings are shown in Table 2.

One patient with a surgical margin positivity in the LPN group had local recurrence. One patient in the OPN group with negative surgical margins (NSMs) and two patients (1.2%) in the LPN group with NSMs had local recurrences within a mean follow-up period of 29.8 months. Two patients in the LPN group with NSMs (1.2%) had bone and lung distant metastases in the 19^{th} and 54^{th} months. The overall recurrence or metastasis rate was 2.8%.

Binary logistic regression analysis was performed to assess the impact of the tumor diameter, laterality, polarity and localization for PSM ($p>0.05$). The individual characteristics of the patients with recurrences or metastases following the PNs are given in Table 3. Three of the patients had recurrence in the LPN group with Fuhrman grade 3, and two had Fuhrman grade 2 tumours.

Table 1. Demographic and clinical variables between the groups

	OPN group (n=46)	LPN group (n=169)	p
Age (years), (mean ± SD[1])	54.7±12.1	55.9±11.9	0.87
BMI[2] (kg/m^2), (mean ± SD)	27.3±4.1	26.8±3.7	0.89
Gender			
Male	22	79	-
Female	24	90	
ASA[3] Score			
I	25	96	-
II	17	56	
III	4	15	
IV	0	2	
GFR[4] (mL/min x1.73 m^2)	91.3±23.2	92±22.4	0.85
Comorbidity			
Hypertension	16	37	-
Diabetes Mellitus	11	17	
Past surgery	17	62	
Symptom			
No	28	109	-
Haematuria	2	3	
Pain	13	42	
LUTS[5]	1	10	
Nonspecific	2	5	
Tumour diameter (mm)	35.3±12.9	30.1±10.8	0.15
Tumour localization			
Right kidney	27	98	-
Left kidney	19	71	
Anterior	32	120	
Posterior	14	49	
Upper pole	14	70	
Middle pole	9	53	
Lower pole	23	46	
Exophytic	41	153	
Endophytic	5	16	
Lateral rim	37	136	
Medial rim	9	33	
Surgical margin (n, %)			
Positive	3 (6.5)	13 (7.7)	0.91
Negative	43 (93.5)	153 (92.3)	0.89

ASA: American Society of Anaesthesiologists score, BMI: Body Mass index, GFR: Glomerular filtration rate, LUTS: Lower urinary tract symptoms, SD: Standard deviation, OPN: Open partial nephrectomy, LPN: Laparoscopic partial nephrectomy, n: Number

Discussion

PN has become the standard surgical method for the treatment of T1 renal tumours with similar oncological results; however, there are still debates with regards to its relationship with PSMs and local recurrences. Our results showed that the tumor diameter, laterality, polarity and localization were not associated with PSM. Kwon et al. (12) showed that local recurrence after a PN was related to the high malignant potential of the tumour and the presence of a PSM. Irrespective of the tumour complexity, a PSM was found to be associated with a higher Nephrometry score, the presence of bilateral tumours, a prior renal cell carcinoma treatment history, local recurrence and distant metastasis when compared to patients with NSMs (13). On the contrary, many institutional data have shown that the surgical margin status did not influence the tumour recurrence risk in pT1 tumours after a PN (14). In a comparative meta-analytical study analyzing the data of 45,786 patients, a larger tumour size, a pT3a stage, nuclear grade 3-4 and minimally invasive procedures, were found to be potential risk factors for a local recurrence. However, cancer-specific and overall survival rates were not increased by the use of minimally invasive procedures (15). Our results showed that local recurrence was observed only in one patient with a PSM in the LPN group, a very low number of patients with NSM showed that there was no association with surgical margin positivity and local recurrence or distant metastasis in both groups. Two of the patients in the LPN group had bone and lung metastasis respectively. One of the patients with distant metastasis had a tumour necrosis (Fuhrman grade 3) and the other had a relatively endophytic mass close to the collection system with microvascular invasion. Histopathological and morphological findings such as high tumour grade and endophytic location of the tumour, may explain the distant metastases in our patients with NSM as reported earlier.

In this study, three patients (6.5%) in the OPN group showed PSM with no local recurrence. Although only a patient in the OPN group and two patients in the LPN group had local recurrence, no difference was observed in cancer-specific or overall survival which is consistent with the literature (16). A previous cohort study of 11,587 patients, showed that the PSM rates were 4.9%, 8.7% and 8.1% for open, robotic and laparoscopic PNs respectively (17). Considering PSM ratios, our results in the OPN group were similar to those of the previously published reports, which may be attributed to the cumulative skills of the urologists in open surgery. The 7.7% PSM rate recorded for the LPN group was similar to that found in literature. However, when a detailed analysis was done, the PSM rate was the highest for the first 50 cases (10.0%), and it decreased to a rate of 8% for the second 50 cases. As previously reported, this can be explained by the need for more complex skills and a relatively long learning curve (18). Consistent with literature, the PSM ratio was only 4.3% in the last 69 patients in the LPN group (19).

Nevertheless, the primary goal should be not to leave a PSM during a PN (7). A healthy parenchymal margin of 1 cm has been suggested for optimal cancer control (20,21). Due to the likelihood of a PSM, challenging cases require close follow-ups and careful surveillance and salvage procedures should

Table 2. Clinical, operative and histopathological findings of the groups					
	OPN group (n=46)		LPN group (n=169)		
	PSM* (n=3)	NSM** (n=43)	PSM (n=13)	NSM (n=156)	p
Haemoglobin (g/dL, mean ± SD*)**					
Preoperative	12.8±2.3	13.2±1.8	13.5±1.3	13.2±1.6	0.66
Postoperative	11.6±2.3	11.8±2.3	12.4±1.6	12.0±1.1	0.65
Serum creatinine (mg/dL, mean ± SD)					
Preoperative	0.8±0.1	0.9±0.3	0.9±0.2	0.8±0.2	0.39
Postoperative	0.7±0.2	1.1±0.4	0.9±0.3	1.0±0.3	0.10
Warm ischaemia time (min, mean ± SD)	10.5±8.0	18.8±8.3	21.2±9.0	21.3±8.9	**0.02**
Surgery time (min, mean ± SD)	160.6±67.4	161.4±69.6	156.8±75.2	136.8±71.1	0.95
Non-klemp (n)	1	1	2	7	-
Surgical technique (n)					
Retroperitoneal	0	8	1	11	-
Transperitoneal	3	35	12	145	-
Blood loss (mL, mean ± SD)	125.0±35.4	137.1±127.0	138.7±43.5	139.6±52.9	0.89
Follow-up (months, mean ± SD) (minimum-maximum)	44.8±13.5 (29-62)	45.6±18.8 (25-90)	46.5±32.4 (25-147)	40.6±18.7 (25-137)	0.93
Local recurrence (n, %)	0	1 (2.2)	1	2 (1.2)	-
Distant metastasis (n, %)	-	-	-	2 (1.2)	-
Time to local recurrence (month mean ± SD)	0	29	3	29.8	-
Histology (n, %)					
Clear cell	2 (4.3)	26 (56.5)	8 (4.7)	111(65.7)	-
Papillary	1 (2.2)	10 (21.7)	3 (1.8)	24 (14.2)	
Chromophobe	0	4 (8.7)	1 (0.6)	12 (7.1)	
Other	0	3 (6.5)	1 (0.6)	9 (5.3)	
Pathological stage (n, %)					
T1a	3	35	9	131	-
T1b	0	8	4	25	
Pathological grade (Fuhrman)					
Grade 1	0	8	1	35	-
Grade 2	3	21	5	71	
Grade 3	0	14	7	50	
Presence of tumour necrosis (n, %)	0	2 (4.3)	1 (0.6)	10 (5.6)	-
Invasion to collecting system (n, %)	-	-	-	-	-
Pernephric infiltration (n, %)	-	-	-	3 (1.8)	-
Vascular invasion (n, %)	-	-	-	-	-

Clinical, operative and histopathological findings of the groups. *PSM: Positive surgical margin, **NSM: Negative surgical margin, ***SD: Standard deviation, OPN: Open partial nephrectomy, LPN: Laparoscopic partial nephrectomy, n: Number, min: Minute

Table 3. Morphological and histological characteristics of the patients with recurrence and metastasis after partial nephrectomy								
Age	Grouping	Tumour type	Fuhrman grade	Largest tumour size (mm)	Surgical margin	Time to recurrence (months)	Local recurrence	Site of metastasis
59	LPN	Clear cell	2	35	-	54	-	Bone
72	LPN	Clear cell	3	12	-	19	-	Lung
71	OPN	Papillary	3	40	-	29	Ipsilateral kidney	-
42	LPN	Papillary	3	42	-	2	Ipsilateral kidney	-
59	LPN	Papillary	3	40	-	8	Ipsilateral kidney	-
73	LPN	Clear cell	2	35	+	3	Ipsilateral kidney	-

OPN: Open partial nephrectomy, LPN: Laparoscopic partial nephrectomy

be reserved for patients with locally advanced or high-grade tumours.

Only two of our patients showed distant metastases in the LPN cases with NSM, but no metastasis was observed in the participants in the OPN group or the LPN patients with PSM. At first glance, although the absence of metastasis in PSM seemed unreasonable, as previously reported, distant metastasis was not only related to the presence of PSM, but also tumour grade, subtype, microvascular invasion, necrosis and tumoural invasion to the collecting system (22).

The WIT is an essential parameter for postoperative kidney function (23). Studies have shown that a lower WIT was associated with better kidney function postoperatively (9). When compared to an OPN, a longer WIT is expected for an LPN (24). This study's result showed that the mean WIT values were significantly less than 25 minutes, particularly in the OPN group.

Study Limitations

Oncological outcomes and PSM rates between LPNs and open partial nephrectomies at a single tertiary referral centre were compared in this study. This study had some limitations including;

1. Lack of a long-term follow-up period

2. The retrospective design of the study

3. Many studies have been done in literature about surgical margin positivity.

Conclusions

The presence of a PSM, although considered to be a risk factor for distant metastasis, was not associated with an increased risk of distant metastasis in this study. Nevertheless, the early stages of the learning curve for an LPN may be associated with higher PSM rates, and this may be a risk factor for distant metastases when combined with other histological and morphological features, such as the nuclear grade of the tumour, the presence of necrosis and endophytic localization.

Acknowledgements

Publication: This study was presented in the 14th International Urooncology Congress on November 6-10 in 2019, Antalya.

Contribution: There is not any contributors who may not be listed as authors.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

Ethics

Ethics Committee Approval: After obtaining Institutional Board Approval from the Clinical Research and Ethics Committee of Zonguldak Bülent Ecevit University (Zonguldak, Turkey) (approval number: 2019-94-12/06, date: 12.06.2019).

Informed Consent: Retrospective study.

Peer-review: Internally and externally peer-reviewed.

Authorship Contributions

Supervision: H.V., Concept Ö.Ç., Design: Ö.Ç., M.Ç.Ç., Ç.G.Ö., Data Collection or Processing: M.Ç.Ç., Ç.G.Ö., B.A.V., Analysis or Interpretation: Ö.Ç., Literature Search: M.S.B., Writing: Ö.Ç.

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