Our Results of Laparoscopic Partial Nephrectomies Without Pedicle Dissection: Possible Advantages and Disadvantages

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Purpose: This study aimed to document the surgical and oncologic results of nephron sparing of non-ischemic laparoscopic partial nephrectomy without the step of hilus controlling and even without dissecting to expose the main renal vascularity and directly focusing on mass removal.

Materials & Methods: The records of the patients who underwent our modified laparoscopic partial nephrectomy technique were evaluated retrospectively. The patients' medical records, including tumor complexity calculated via R.E.N.A.L nephrometry scores, operation time, estimated blood loss, blood transfusions, hospital stay, pre- and postoperative serum creatinine levels, complications via the Clavien classification system, pathological status of surgical margin, and follow-up times, were documented.

Result: The data of 55 patients with 58 renal units were evaluated. Almost all tumors were in the low complex group (91%), with a mean size of 31.74 ± 7.38 mm (range: 12-46 mm). Mean operation time, estimated blood loss, and transfusion rates were 138.62 ± 38.45 minutes (range: 90-240 min), 242.24 ± 107.12 mL (range: 100-500 mL), and 19%, respectively. The hemoglobin level decreased by a mean of 2.05 ± 0.87 g/dL. Whereas the perioperative complications were Clavien grades I, II, and III (74%, 23%, and 3%, respectively), mean hospital stay and follow-up time were 4.05 ± 1.97 and 19.67 ± 13.57 (ranges: 2-10 days and 1-44 months), respectively.

Conclusion: Present un-controlled results pointed that tumor-focusing nephron-sparing non-ischemic partial laparoscopic nephrectomy may be preferable for small-sized, low-complex renal masses.

Keywords: laparoscopic partial nephrectomy; renal hilus dissection; tumor-focusing laparoscopy; zero ischemia

INTRODUCTION

The term "renal incidentaloma" was generally used to define small renal masses that were reported incidentally due to the widespread use of high technologic diagnostic instruments for nonspecific abdominal symptoms.[(1)] Since the advances in urological surgical techniques, laparoscopic partial nephrectomy (LPN) and robotic-assisted LPN are now the common procedures, instead of open surgery, for the treatment of small renal masses, meaning the clinical T1a (< 4 cm) tumors.[(2-5)] In the classical surgical description, after the standard steps of renal laparoscopic approaches and dissections, hilar control was maintained and the main vessels that carrying one-fifth of the cardiac output were prepared for possible ischemic occlusion or subsequent nephrectomy.[(5)] Intraoperative ultrasonography can be used to confirm the location, width, and depth of the tumor after this step.[(6)] The main goals of LPN are to complete tumor excision without positive margins, obtain hemostasis, and decrease or even eliminate the warm ischemia time. Since every minute of ischemia is regarded as precious time to save renal function, the term of "zero ischemia" became popular for endoscopic procedures that were conducted without hilar clamping.[(7,8)]

In this pioneer study, we documented our surgical and oncologic results of non-ischemic LPN that directly focused on mass resection without hilus dissection to expose the main renal vascularity for immediate control.

MATERIALS AND METHODS

The records of patients who underwent LPN for renal masses were evaluated retrospectively. Almost all cases were treated by a single surgeon in a single center. The data collected between April 2012 and June 2016 were included. The patients were clearly informed about their disease and the surgical procedure that would be performed at our clinic, as well as its possible complications. All subjects signed informed consent forms. The institutional review board approved the study. Non-oncologic and high-complexity tumors were excluded from the study. The demographic characteristics and body mass index (BMI kg/m^2) of the patients were documented. The patients' medical records, including tumor size, operation time (OT), estimated blood loss (EBL), blood transfusions, hospital stay, pre- and post-

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Table 1: Demographic and perioperative data of the patients who underwent Laparoscopic partial nephrectomy.

	Minimum	**Maximum**	**Median** (Mean ± SD)
Age (years)	28	79	48.32 ± 13.82
Body mass index (kg/m^2)	21.6	45.87	29.1
Size (mm)	12	46	32
Operation time (min.)	90	240	120
Hospital stay (day)	2	10	3
Estimated blood loss (mL)	100	500	200
Decrease in Hg (gr/dL)	1	4,5	2
Follow up (month)	1	50	15

operative serum creatinine levels, and follow-up times were evaluated. Complications were evaluated and graded according to the modified Clavien classification system (I-V).[9] R.E.N.A.L (Radius of the tumor size/ Exophytic/Nearness to collecting system/Anterior/Location) nephrometry scores were used to establish the tumor complexity with evaluating the tumor anatomy.[10] All patients underwent same surgical procedure. While the patients with full hospital data were included in the study, the ones with end stage renal disease and patients who underwent previous renal surgery for any reason were excluded.

Surgical Technique: All laparoscopic interventions were started transperitoneally using a Veress needle or Hasson access. Access through three ports (5–10 mm) was achieved at the 70–90o lateral decubitus position of the patient. The umbilicus as a natural orifice had always been our preference, because we had patients with relatively low BMI (~30), with the rare exception. The pneumo-peritoneum media was maintained at 12 mm Hg. However, this level rised up to 14-16 mm-Hg during the steps of tumor excision and hemostatic suturation of renal defect if necessary. This pressure was raised up to 18 in very transient periods in very rare events and any other maneuver was made for renal compression. The 4th port was optionally inserted based on the requirement of the case, but mostly to assist with and continue suction drainage. A second suction was never used. The white line of Toldt and the triangular hepatic and lienocolic ligaments were also dissected, if necessary. After the medialization of the ipsilateral colonic segment, Gerota's fascia on the probable renal mass was opened without the use of intraoperative ultrasonography. Then, the mass was excised using cold and electrocautery scissors while ensuring an adequate margin. Any extra renal parenchyma was removed to prevent tumor-positivity at the surgical margin. The LigaSure Impact™ (5-10 mm) electrosurgical bipolar vessel sealing system was used in every step of the surgery. After the total excision of the tumor, as almost standard laparoscopic renal defect closing technique; any vessels or collecting system tributaries at the resection site were repaired by several horizontal continuous running mattress sutures (suture material; 15cm prepared V-Loc Covidien® wound closure device) to ensure hemostasis and repair any collecting system violations as a inner level suturation. If needed, these sutures could individually be tied, and a hem-o-lok clip was placed on each end to secure the suture and prevent it from pulling through as previously described by Gill IS et al.[5] Renorhaphy, as a total closer of renal defect by a second layer, was performed by running-clip technique with the same suture material; The sutures were performed sequentially in a running manner, and sequential tightening and locking were performed with Hem-o-lok clips as as previously described by Kim KS et al. and figured by Montorsi F et al.[11,12] Tissue sealants and thrombogenic agents were never used. An endobag was used for retrieving the complete specimen without the enlargement of the trocar incision. A tick drainage tube was inserted through one of the suitable side ports and removed after 24 hours when the bloody effusion ceased.

Pathologic evaluation: The surgical specimens were processed in accordance with the standard pathologic procedures, and staging was performed based on the 7th edition of the American Joint Committee on Cancer Classification System (AJCC/UICC TNM).(13) Samples from the tumor, including surrounding renal parenchyma that had a thickness of 0.2–0.3 cm, were prepared. Whereas all small-sized (less than 2.5 cm) tumors were completely sampled, at least 7 to 8 samples were selected from different areas of the tumor in the remaining large ones. Slices were prepared from each paraffin block in 4-micron sections and stained with hematoxylin-eosin. In microscopic examination, if the distance of the tumor was 1 mm or more from the inked surgical margin, the surgical margin was reported as negative.

RESULTS

The hospital records of a total of 58 renal units of 55 patients (34 men and 21 women) were evaluated for the present study. The mean age of the subjects was 48.32 ± 13.82 years (range: 28–79 yr). Benign lesions and complex masses were excluded from the study. While three male patients underwent subsequent LPN at the contra/ipsilateral side in another session for the same indication, none of them was for the surgical site. The mean BMI of the patients was 29.37 ± 4.73 kg/m^2 (range: 21.6 to 45.87 kg/m^2) (**Table 1**). Mean pre-operative creatinine values were 0.82 mg/dL (0.5-1.7), postoperative first day creatinine was 1.07 mg/dL (0.5-2.2) and postoperative first month creatinine was 0.89 mg/dL (0.5-1.8). There was no statistically significant difference between preoperative and postoperative first month creatinine levels ($P > 0.05$). The patients' medical data related to the operation, such as tumor size, operation time (OT), estimatedf blood loss (EBL), hospital stay, and follow-up times are noted in **Table 1**. Any perioperative complications resulting from laparoscopic surgery were reported. The hemoglobin (Hb) level decreased by a mean of 2.05 ± 0.87 g/dL (range: 1-4.5 g/dL). Moreover, the postoperative period was uneventful without major complications. However, due to continued postoperative bloody effusion through the surgical region drainage system and decrease of Hb level to below 10 g/dL, 11 patients required one to three units of blood via transfusion. Enucleation of the mass was possible in eighteen (31%) of all sessions. All

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Table 2: Tumor location, pathologic report, Clavien and R.E.N.A.L (Radius of the tumor size / Exophytic / Nearness to collecting system / Anterior / Location) nephrometry scores of the patients.

	n	%
Tumor side		
Right	29	50
Left	29	50
Tumor location		
Lower pole	24	41
Middle pole	14	24
Higher pole	20	35
Pathology of surgical margin (SM)		
Eneculation	18	31
SM (-)	38	66
SM (+)	2	3
Renal Nephrometry (R.E.N.A.L) score		
Low complexity (4-6)	53	91
Moderate complexity (7-9)	5	9
Clavien-Dindo grading system (n)		
Clavien 1	43	74
Clavien 2	13	23
Clavien 3	2	3

pathologic reports showed renal cell carcinoma (RCC) with subtypes as; Clear cell (n: 50) and Papillary (n: 8) and tumor-negative at the surgical margin, except for two (3.4%). No recurrence was noted at the surgical site during the control radiologic imagings during a mean follow-up of 19.67 ± 13.57 months (range: 1-50 months). Neither urine leakage nor need of peri- or postoperative double J catheter was reported. Pre- and postoperative renal functions did not alter depending on the serum creatinine levels. Clavien scores were noted to be Grade I (n = 43, 74%), II (n = 13, 23%), and III (n = 2, 3%) and were treated conservatively with antibiotics or blood transfusions, R.E.N.A.L nephrometry scores demonstrated mostly (91.4%) low tumor complexity, and the remaining ones were moderate (8.6%), with no high complexity. These data are summarized in **Table 2**.

There was a statistically significant relationship between the R.E.N.A.L score and the duration of hospitalization, the estimated blood loss and the Clavien score in the positive correlation of 32.6%, 70.4% and 61.9%, respectively (*P* = .012; *P* = .001; *P* = .001)(**Table 3**).

DISCUSSION

LPN as a minimally invasive procedure has strict advantages such as short hospital stay, quick recuperation and less postoperative discomfort, less blood loss, and no surgical scar compared with an open surgical technique.[2] In this study, we aimed to represent the results of our patients who underwent LPN without hilar clamping and dissecting and just targeting the renal mass directly and discussed its possible advantages and disadvantages.

Table 3: The correlation of R.E.N.A.L score with duration of hospitalization, estimated blood loss and Clavien score

	R.E.N.A.L score	
	r	*p*
Hospital stay (day)	0,326	,012*
Estimated blood loss (mL)	0,704	,001*
Clavien score	0,619	,001*

r: Spearman's rho correlation coefficient * $p < 0.05$

Hilar clamping has the advantage of lower blood loss, shorter OT, and better surgical performance despite its disadvantage of possible irreversible renal function loss compared with the unclamped method.[6] However, the classic unclamping method also requires a hilar dissection step for patient and oncologic safety reasons. Skipping this time-consuming surgical step, which is the dissection of the renal hilus to isolate the renal artery and vein and also the kidney dissection from the surrounding tissues according to the standard LPN, may provide a decreased OT. Present OTs (mean: 139 min) seemed to be a bit short in comparison with some non-ischemic LPN series in the literature (160-210 min).[14,15] In our opinion, this relatively simplified surgical technique confirms our previous hypothesis that cases of cancer of the upper urinary system should not be excluded, even in the initial laparoscopic learning curve, based on the results of our early laparoscopic surgical series.[16] Nevertheless, one of the limitations of this modified surgical procedure is that the surgical team should be experienced in both open and laparoscopic surgery because an urgent open procedure may be required in cases of severe bleeding to control the renal pedicle. Thus, instead of a retroperitoneal approach, a transperitoneal-approach LPN was suggested for immediate control of the renal pedicle. However, any need of changing the planned surgical procedure was reported in our pioneer series. Parallelly, in a robotic assist nephron sparing surgical series with clamping and off-clamping groups, Acar O et al. concluded that non-ischemic option could be applied even in initial learning curve but with an expert surgeon in open surgery, however, unlikely to our study, authors preferred hilus dissection to enable rapid hilar control even in off-clamped group.[17] Due to the fact that the present study is a non-ischemic form of LPN, the blood loss is considered to be more than in the ischemic type.[6] Our mean EBL, which was approximately 240 mL, was similar to those of a recent systematic review and meta-analytic study involving mixed LPN studies that included clamped–unclamped and undefined methodologies (100–400 mL).[18] Furthermore, Aron et al. reported EBL as 300 mL in their small series (n = 12) with unclamped or early unclamped LPN.[19] However, there were some discordance between present EBL and Hb values. Most of the present blood lost was represent the measurement of the liquid at the aspiration tube after the subtract of the irrigation water. Thus calculation discordance should bear in mind. On the other hand, some bleeding might spread over the abdomen and also the coagulated ones that skiped from the aspiration and the postoperative suction drainage. All in all, we think that the drop in serum Hb levels (mean approximately 2 g/dl) were more predictive to monitor the blood loss in our study. A small, but significant, number (19%) of our patients needed blood transfusions due to a decrease in serum hemoglobin level below 10 g/dL. Our blood transfusion rate (BTr: 19) was slightly higher than that in the high-volume study (BTr: 11) that involved the combined cases who underwent either clamped or unclamped LPN and robotic-assist LPN.[20] On the other hand, although it was not clearly reported in the literature, it should be considered that hilar dissection can expose the main renal vascularity to some very serious complications such as renal vascular perforations and thrombosis (e.g., main or segmental renal artery or

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vein, gonadal artery, lumbar vein), which may increase the morbidity rates of the standard LPN and possibly lead to urgent nephrectomies, carrying a perioperative mortality risk. For example, in a large series with over 150 cases for planned LPN, some of them (3.3%) were switched to laparoscopic nephrectomies (LN) for undefined reasons during the operation.[14] In a meta-analysis, this conversion rate from LPN to LN is defined as 0% to 12%.[18] Nevertheless, we think that the surgical site hemorrhage in the present study cannot have resulted in unnecessary nephrectomies even if the surgical strategy changed to the open procedure perioperatively due to the involvement of a few segmental arteries. Besides, the rate of switching from LPN to open surgery noted in the literature is 0% to 14%. Surprisingly, the reports that were close to the high point of the range were relatively recent reports instead of reports from the beginning of the laparoscopic revolution period.[18,21,22] It should be expected that these aforementioned rates LPN to LN or open surgery decrease to zero during the laparoscopic learning curve of the urology clinics. However, conversely, in the assessment of these data, it can be noted that LPN always has the risk of converting to LN and open procedure as partial/total nephrectomies in any clinic and with any surgeon. Furthermore, postoperative lymphatic leakage (0.5%) is another possible special morbidity for conventional LPN, but not the present one, due to the destroying of the small vascularities, including the lymphatics of the renal hilum.[18,22] Urinary leakage claimed to be more often in LPN series in comparison with the open PN[23], however we had any this kind of complication, probably, due to the reason that our series involved mostly uncomplicated small exophitic masses.

The resection site hemorrhage during the procedure can be regarded as a frustrating factor for a safe surgical margin, and thus it might be claimed that there may be an increased risk for residue tumor at the resection region. As supporting this determination, enucleation of the renal masses occurred in 1/3 of our cases and could be regarded as oncologically unsafe procedure. Nevertheless, Zhang K reported that even 1mm inside the normal tissue was enough for a safe surgical margin.[24] However, all of our patients' (except for two, 3.4%) pathology reports showed a negative surgical margin. This positive surgical margin rate was reported in a wide range as 0–11 in an LPN series.[18] Moreover, there was no reported recurrence in the original operation region in our series with a mean of 20 months follow-up. On the other hand, in connection with one of the aims of this study, enucleation can be regarded as another nephron-sparing surgery (NSS) option that theoretically involves any functional cancer-free nephron inside the pathologic specimen.

Renal hilus dissection for controlling renal pedicle either for the requirement of warm ischemia or switching to LN in the case of uncontrolled perioperative severe renal bleeding is regarded as a sine qua non of standard LPN. Moreover, the literature point to the popularity of non-ischemic LPN for nephron-sparing concerns.[25] The present surgical approach for low complex small masses cannot be expected to result in renal functional abnormalities per-operatively and can be regarded as almost purely nephron sparing. Nonetheless, non-ischemic LPN also drives through the renal pedicle exposition after a careful dissection. On the other hand, we think that severe life-threatening renal hemorrhage is not possible in small (≤ 4 cm) exophitic lesions of the kidney based on our results; thus, hilar controlling and the dissection for exposing the main renal vascularity are not mandatory. These masses in the present group were mostly (91%) low complexity according to R.E.N.A.L nephrometry scores, which is a classification for predicting blood loss and the type of surgery required (either open or LPN).[26] R.E.N.A.L nephrometry scores were created to standardize anatomical tumor definition. In our opinion, the R.E.N.A.L score may also help in selecting patients for our modified LPN technique. Furthermore, in a study evaluating standard LPN (with hilus control) in two groups with Renal mass below and above 4 cm, authors interestingly found that there was no differences in the peroperative complications in selected cases.[27]

Another disadvantage of renal hilus dissection for renal pedicle control is the possible difficult exposition in the ipsilateral secondary operations in cases of recurrence due to residual cancer or micro-multifocalities.[28] However, the primary tumor-focusing surgery provides a safer operation site via virgin renal hilus for the secondary procedures such as LPN or LN. Finally, defined tumor-focusingLPN without renal pedicle exposition is convenient for robotic-assist LPN and also the principles of laparoendoscopic single-site surgery (LESS). Kawai et al. described LESS LPN without hilar clamping in seven patients with similar tumor size (≤ 4 cm). No patient required blood transfusion, but one of them was converted to conventional LPN due to massive bleeding. However, it was unclear whether they prepared the renal pedicle initially and, in addition, whether they preferred a special cutting instrument such as a microwave tissue coagulator.[29] We did not use special instruments; all procedures were conducted via the available standard surgical instruments. In regard to the reducing the invasiveness of the procedure, we should mention that all of our procedures were conducted using three to four ports, but not a fifth one. The fifth trocar for hilar clamping was standard in the conventional LPN procedure.[5]

With respect to present technique involving zero ischemia with zero hilar dissection, some authors introduce the method as selective renal parenchyma compression with special clamps (Simon's clamp) that provide a relatively safe alternative to local ischemia, far from the renal pedicle inn the resection region, especially in polar renal tumors.[30] However, an advantage in the present procedure is that there is no need for a special instrument through a new port site and, moreover, local ischemia caused by Simon's clamp may be harmful to the local nephrons distal to the clamp. Furthermore, the clamp itself can cause massive bleeding and nephron destruction. Segmental artery clamping is another way to increase the effect of NSS, but it cannot be considered less invasive.[31] Another recent effort for NSS during LPN is "controlled hypotension anesthesia," which reduces the renal circulation during the procedure. This method is performed without renal hilar clamping, but with hilar control.[32] The other challenging minimally invasive procedures for nephron sparing, such as cryoablation and radiofrequency ablation, microwave thermotherapy, and laser interstitial thermal therapy, can be regarded as ongoing discussion topics, but have not been included in this article.[6]

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The main limitation of this study was its uncontrolled retrospective design with limited subjects. Thus some data seemed to have discordance such as the EBL and decreased Hb levels, although the possible explanations have been discussed. Furthermore, as another restriction, all cases were not conducted by single surgeon.
To conclude, we found that tumor-focusing LPN is preferred for small-sized exophitic renal masses, and that this procedure is in accord with nephron-sparing principles. The results of this pioneer study should be confirmed by large-volume prospective controlled studies with groups of conventional LPN and tumor-focusing LPN with the same tumor sizes and locations.

CONCLUSIONS

Despite the relatively high transfusion rate, this simplified LPN technique can be an alternative option and seemed to be without disrupting either patient or oncologic safety, especially for uncomplicated renal masses.

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