Feasibility and Outcomes of Laparoscopic Renal Intervention After Prior Open Ipsilateral Retroperitoneal Surgery

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Abstract

Background and Purpose: Treating patients with renal-cell carcinoma (RCC) after previous retroperitoneal surgery (renal or adrenal) is technically challenging. We present our initial experience with laparoscopic renal interventions (LRI) after previous open retroperitoneal surgery in patients needing ipsilateral renal intervention. We report on feasibility, functional and oncologic outcomes of LRI after previous open retroperitoneal surgery.

Patients and Methods: We reviewed records of patients undergoing attempted laparoscopic or robot-assisted renal intervention after at least one previous open ipsilateral retroperitoneal surgery. We identified 34 patients who underwent 39 staged attempted LRI after 48 previous open ipsilateral renal or adrenal surgeries. The LRI included 20 minimally invasive partial nephrectomies (MIPN), 11 laparoscopic radiofrequency ablations (LRFA), and 8 laparoscopic nephrectomies (LTN). Demographic, perioperative, renal functional, and oncologic outcome data were collected. Statistical analyses were performed to identify risks for conversion to open surgery.

Results: No attempted nephron-sparing procedure resulted in kidney loss. Overall conversion rate of the cohort was 28% and was highest in the MIPN group (40%). On univariate analysis, only multiple tumors that were treated significantly increased chances of open conversion ($P < 0.01$). Subset analysis demonstrated similar rates of blood loss, operative times, and conversion rates in patients undergoing partial nephrectomy having previous open partial nephrectomy compared with previous open adrenal surgery only. There was no significant difference in preservation of renal function between MIPN and LRFA, with more than 85% of preoperative renal function preserved. Mean follow-up of 11.9 months (range 1–97.5 mos) metastasis-free survival and overall survival was 94.1% and 97%, respectively.

Conclusions: LRI after previous open ipsilateral retroperitoneal surgery is feasible. Repeated partial nephrectomy has the highest conversion risks among the laparoscopic renal interventions and appears to be independent of previous renal or adrenal procedure. Attempting repeated LRI for multiple tumors is a significant risk factor for open conversion. Renal functional and oncologic outcomes are encouraging at early follow-up.

Introduction

PREVIOUS ABDOMINAL SURGERY has been demonstrated to increase the challenges of transperitoneal laparoscopic renal surgery.^{1,2} Using nephron-sparing surgery in patients with recurrent disease or *de novo* tumors after previous ipsilateral retroperitoneal surgery is particularly challenging secondary to scarring after previous hilar dissection and renal mobilization.^{3–5} The obliterated surgical planes can impact outcomes in the hands of both open and laparoscopic surgeons, increasing the morbidity of either surgical approach.

Laparoscopic partial nephrectomy (LPN) and more recently robot-assisted laparoscopic partial nephrectomy (RAPN) have been described and established as minimally invasive alternatives to open partial nephrectomy (OPN).^{6,7} Initially used to remove solitary small exophytic renal masses, these techniques have expanded to include large, hilar tumors as well as multiple renal masses.^{8,9} Despite refinements in technique, little is known about the role and outcomes of minimally invasive intervention after previous open retroperitoneal surgery. As the indications for nephron-sparing or adrenal-sparing surgery expand, there will likely be a

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potential increase in the need for repeated retroperitoneal intervention for metachronous or multifocal renal-cell carcinoma (RCC).

While the prevalence of multifocality in the sporadic population has been described to exist between 4.3% and 25%, the rate of multifocal disease, local recurrence, or *de novo* tumor formation is considerably higher in the hereditary renal cancer population.¹⁰⁻¹⁴ Synchronous or metachronous adrenal pheochromocytomas and RCC tend to develop in patients with certain hereditary cancer syndromes, such as von Hippel-Lindau. These patients are, therefore, often subjected to highly morbid repeated retroperitoneal surgeries and extended convalescence periods.

Reoperative renal surgery has been described as technically challenging but oncologically sound and an effective treatment to avoid the morbidity of renal replacement therapy.^{3,4} In an attempt to decrease the morbidity of repeated open surgery, a cohort of patients in our institution were treated with minimally invasive partial nephrectomy (MIPN) (laparoscopic or robot assisted laparoscopic), laparoscopic radiofrequency ablation (LRFA), or laparoscopic total nephrectomy (LTN). In this study, we evaluate our initial experience with laparoscopic renal interventions (LRI) after previous open ipsilateral retroperitoneal surgery and report on perioperative, oncologic, and renal functional outcomes.

Patients and Methods

We queried our prospectively maintained database to identify patients undergoing attempted laparoscopic or robot-assisted renal intervention at the National Institutes of Health after at least one previous open ipsilateral retroperitoneal surgery (renal or adrenal). Data were obtained from reviews of history and physical examinations, operative and pathology reports, anesthesia records during hospital admission, and follow-up visits. All patients were evaluated on a protocol approved by the Institutional Review Board. The choice of LRI was decided based on the tumor number, location, patient health status, and patient preference. The decision to perform LTN was determined by the surgical team preoperatively based on a poorly functioning ipsilateral renal scan (less than 15%) or the determination that nephron-sparing surgery would not leave the patient with a reasonably

functioning renal remnant. LRFA was performed between 2001 and 2003 on a protocol to evaluate the efficacy of performing RFA on hereditary renal patients with renal masses. LRFA was performed using standard techniques as described previously.¹⁵ The selection of the minimally invasive partial nephrectomy approach was influenced by the shift toward increased laparoscopic and robotic utilization at our institution.

Preoperative evaluation included abdominal and chest imaging, routine laboratory analysis, and nuclear renal scans in patients with both kidneys in place. All studies were repeated 3 months after surgery, and subsequent imaging was performed yearly or more frequently at the discretion of the treating team.

For those undergoing nephron-sparing procedures, functional outcomes were assessed using serum creatinine level, eGFR calculated by the Modification of Diet in Renal Disease formula, and nuclear renography.¹⁶ Oncologic outcomes were assessed by the development of metastatic disease on postoperative imaging and the need for subsequent renal intervention on the same unit. Logistic regression analyses were performed to identify risks for conversion to open surgery. Variables analyzed included procedure type, age, sex, body mass index (BMI), tumor size, number of previous interventions, and number of tumors treated. The generalized estimation equation approach was used to fit the univariate logistic model to account for inpatient correlation of multiple outcomes. Chi square was used for multiple group comparison with statistical significance defined as $P \leq 0.05$.

Results

We identified 39 LRIs that were attempted in 34 patients, which included 20 minimally invasive partial nephrectomies: 14 LPN, 6 RAPN, 11 LRFA and 8 LTN. Clinical characteristics are listed in Table 1. Of the 48 previous open ipsilateral retroperitoneal interventions, 39 were OPN and 9 adrenalectomies (partial or total). In addition, four patients underwent LRFA previous to their open retroperitoneal surgery. The average time between open intervention and LRI was 95.5 months (range 12–480 mos). Of the 34 patients, 22 were men and 12 were women. Mean patient age was 49 years (range 28–70 years). The majority of patients in the study (88%) had known hereditary renal cancer syndromes.

TABLE 1. CLINICAL CHARACTERISTICS FOR PATIENTS UNDERGOING REPEATED LAPAROSCOPIC RENAL INTERVENTIONS

	MIPN	LRFA	LTN	P value*
Total patients	17	10	7	
Total no. of surgeries	20	11	8	
Mean age, years (range)	47.55 (28–65)	49 (42–58)	49 (27–70)	0.84
Mean BMI, kg/m ² (range)	31.9 (23.3–40.4)	28 (21.7–36.4)	32.6 (22.1–53)	0.37
Male (%)	13 (72)	4 (44.4)	5 (71.4)	0.41
Caucasian (%)	16 (94)	10 (100)	7 (87)	0.49
Right side (%)	10 (50)	7 (64)	3 (38)	0.58
Mean no. of previous interventions, (range)	1.14 (1–2)	1.55 (1–3)	1.5 (1–3)	0.37
Mean interval time from previous surgery, mos (range)	114 (37–480)	69 (12–132)	83.4 (12–240)	0.28
Mean largest tumor size, cm (range)	3.22 (2.0–4.5)	2.7 (1.6–3.2)	3 (2.5–5)	0.03
% malignant tumors	100	100	100	
Median follow-up, mos (range)	24.5 (3.8–86.6)	73.5 (34.1–97.5)	8.37 (0.7–25.8)	<0.01

*Chi square for multiple groups comparison.

MIPN=minimally invasive partial nephrectomy; LRFA=laparoscopic radiofrequency ablation; LTN=laparoscopic total nephrectomy; BMI=body mass index.

TABLE 2. PERIOPERATIVE OUTCOMES

	MIPN	LRFA	LTN	P value*
No. surgeries	20	11	8	
No. conversions (%)	8 (40)	2 (18)	1 (12.5)	0.43
No. renal unit loss (%)	0	0	NA	—
Mean EBL, mL (range)	442 (50–1100)	69.4 (0–150)	392.8 (100–1000)	<0.01
No. of tumors treated, mean (range)	3.15 (1–10)	1.45 (1–4)	N/A	0.01
Mean operative time, min (range)	333 (145–520)	215 (148–345)	341 (140–575)	0.02
No. hilar clamping (%)	9 (75)	0 (0)	NA	—
Mean WIT, min (range)	32.4 (19–49)	0	NA	—
No. complications (%)	1 (8.3)	1 (11.1)	0 (0)	—
No. patients transfused (%)	0 (0)	0 (0)	1 (14.3)	—

*Chi square for multiple group comparison

MIPN=minimally invasive partial nephrectomy; LRFA=laparoscopic radiofrequency ablation; LTN=laparoscopic total nephrectomy; NA=not applicable; EBL=estimated blood loss; WIT=warm ischemia time.

Perioperative outcomes are listed in Table 2. Twenty-eight of 39 attempted LRI cases were completed laparoscopically (72%). For those cases successfully completed laparoscopically, the overall complication rate was 7.1% (2 of 28). A proximal ureteral stricture that developed in one patient who underwent successful repeated RAPN is currently being managed with an indwelling stent. The ureteropelvic junction obstruction that occurred in a second patient who underwent LRFA was repaired during OPN 10 months later. There were five other complications observed in cases necessitating open conversion. These included a pancreatic leak, a wound infection, postoperative pulmonary edema, a urine leak, and ipsilateral hydronephrosis managed with temporary stent placement.

Eleven of 39 (28%) cases needed operative conversion to open surgery: 8 in the MIPN group (40%), 2 in the LRFA group (18%), and 1 in the LTN group (12.5%). Reasons for case conversion as dictated in the final operative report included scarred renal hilum in four cases, difficulty with renal mobilization in three cases, failed access in two cases, additional tumors identified intraoperatively in one case, and severe abdominal adhesions in one patient. Univariate analysis to assess risk of open conversion is displayed in Table 3. Among several variables tested, treating more than one tumor significantly increased conversion risk ($P<0.01$). Among pa-

tients undergoing repeated MIPN, a subset analysis was performed comparing the group of patients after previous partial nephrectomy with or without adrenal surgery ($N=15$) compared with patients with previous adrenal surgery alone ($N=5$). Similar rates of blood loss (890 mL *vs* 1190 mL), operative times (389 *vs* 394 min), and conversion rates (40% each group) were observed.

Renal functional outcomes are displayed in Table 4. There were no significant differences regarding renal function when comparing the MIPN with the LRFA group. At median follow-up of 11.9 months (range 1–97.5 mos), metastasis-free survival and overall survival were 94.1% and 97%, respectively. Metastatic disease did not develop in any patient during follow-up. Two patients had metastasis at the time of their surgeries: One patient with von Hippel-Lindau disease had a uniquely aggressive sarcomatoid tumor on final pathology determination and subsequently progressed with metastatic disease; a second patient had sporadic Fuhrman grade 3 RCC with metastatic disease at the time of LTN and needed cytoreductive nephrectomy. Both patients have succumbed to their disease at 21 and 23 months after their surgeries, respectively.

Discussion

Reoperative retroperitoneal surgery remains a technical challenge to urologic surgeons. Intra-abdominal adhesions have been reported in 75% to 90% of patients with a history of open abdominal surgery.¹⁷ Adhesions may distort tissue planes and alter the normal location of critical structures in an unpredictable fashion. Additional effects of previous retroperitoneal surgery, particularly on the kidney, include challenges with renal mobilization and excessive hilar scarring compromising the exposure and increasing the risk of damage to vital vasculature. Having the outcome information for open repeated renal surgeries previously published by our group, we chose to evaluate the role of a minimally invasive approach in a reoperative field.^{3,4}

When analyzing the outcomes of the three LRI procedures after previous open retroperitoneal surgery and primarily OPN, we found that LTN had the fewest complications (none) among the three groups. MIPN, on the other hand, appeared to be the most technically challenging of the three groups with the highest blood loss and highest conversion rates when

TABLE 3. UNIVARIATE LOGISTIC MODEL TO PREDICT CONVERSIONS

Variable	P value*
Procedure type (MIPN, RFA, LTN)	0.43
Age	0.86
Sex	0.36
BMI	0.31
Tumor size	0.75
No. of previous procedures	0.89
No. of tumors (1 <i>vs</i> >1)	<0.01
Clear-cell histology (Yes/No)	0.87

*Generalized estimation equation approach was used to fit the univariate logistic model to account for inpatient correlation of multiple outcomes.

MIPN=minimally invasive partial nephrectomy; RFA=radiofrequency ablation; LTN=laparoscopic total nephrectomy; BMI=body mass index.

TABLE 4. RENAL FUNCTIONAL OUTCOMES FOR PATIENTS TREATED WITH NEPHRON-SPARING PROCEDURES

	MIPN (n = 20)	LRFA (n = 11)	P value*
Mean decrease serum creatinine (mg/dL) (%)	0.09 (8.8)	0.14 (11.7)	0.19
Mean decrease eGFR (mL/min/1.74 m ²) (%)	9.2 (10.4)	9.3 (12.5)	0.49
Mean decrease ipsilateral renal scan function (%)	6.8 (13.1)	5.9 (13.8)	0.34

MIPN = minimally invasive partial nephrectomy; LRFA = laparoscopic radiofrequency ablation; eGFR = estimated glomerular filtration rate.

*Intergroup comparison by chi-square test.

compared with both LRFA and LTN. Operative times of MIPN and LTN were nearly double that of LRFA, suggesting that these surgeries needed more renal dissection and mobilization compared with the ablative cases. Challenges associated with performing MIPN after OPN have been previously reported by Turna and associates,⁵ who described similar findings when comparing MIPN after renal biopsy, percutaneous nephrolithotomy, pyeloplasty, or nephrolithotomy. Our observations are consistent with their findings.

In the present series, the complication rate for cases completed successfully without conversion was 7.1%, commensurate with previous published reports for laparoscopic urologic procedures.¹⁸ This finding implies that if the reoperative field permits adequate exposure to allow for completion of the operation in a minimally invasive setting, then an additional risk of complications may not be anticipated. When LRI necessitated open conversion in our series, however, the complication rate more than doubled (17.9%), suggesting more treacherous surgical terrain. Complication rates under these circumstances are still significantly lower than our repeated OPN series, where complication rates of up to 43% were reported.⁴ This underscores the importance of patient selection, the role of appropriate preoperative counseling, and the early recognition of the need to convert. Despite technical challenges, it is important to recognize that no kidneys were lost in patients undergoing attempted repeated MIPN, even if it necessitated a conversion to open surgery.

Although open conversion is not viewed as a complication, it is an important component in assessing the potential risks *vs* benefits of laparoscopic surgery and can impact patients in regard to postoperative pain, hospital stay, and convalescence. In addition, the ability to accurately quantify the risk of conversion is important for patient counseling, especially in the patient needing reoperative surgery. Richstone and colleagues¹⁹ reported an open conversion risk of 3.3% in 2128 patients undergoing laparoscopic renal operations including TPN and LPN. Vascular injury was the most commonly reported reason for conversion (38%). Other institutions have reported similar rates of conversion in the literature.^{18,20} Historically, published reports have predominantly included surgically naïve patients with conversion rates much lower than in our present series (28%). Challenges with a purely laparoscopic approach in similar scenarios have been confirmed by other series evaluating outcomes of laparoscopic after open surgery.^{1,2}

Logistic regression analysis identified that treating more than 1 tumor was the only independent risk factor for conversion. This may explain the highest conversion rate (40%) in patients treated with MIPN, because they had the highest number of tumors treated (3.15). Interestingly, procedure type was not an independent risk factor for conversion. Other published reports have identified age and BMI as indepen-

dent risk factors for conversions, neither of which was found to be significant in our cohort.^{19,21} In addition, our subset analysis demonstrated that in the MIPN group, patients with previous partial nephrectomy *vs* previous adrenal surgery had similar blood loss, operative times, and conversion rates. Although this may initially appear counterintuitive, it suggests that repeated surgical exposure of the retroperitoneum remains technically challenging, even when the renal hilum has not been previously dissected.

Previous abdominal surgery has not historically precluded the successful performance of safe laparoscopic procedures. Laparoscopic cholecystectomy, adrenalectomy, and colorectal surgery after previous abdominal surgery have all been established to be safe and feasible procedures.^{21–23} In the urologic literature, Parson and associates²⁴ and Pautler and coworkers²⁵ independently concluded that previous abdominal surgery did not adversely affect subsequent urologic laparoscopy, nor did it reliably predict the incidence of postoperative adhesion formation. Although these studies may be accurate in most circumstances, very few studies included patients who underwent previous open retroperitoneal surgery.

Several observations support our attempt to use LRI after previous open retroperitoneal surgery in the hereditary renal population: (1) Previous reports demonstrate the feasibility of laparoscopic after open surgery in both the urologic and general surgery literature^{22,25}; (2) our institution's experience in performing reoperative renal surgery may facilitate transitioning to a minimally invasive approach; (3) the high morbidity of repeated renal interventions has been demonstrated in our previous open series⁴; and (4) the potential for decreased subsequent adhesion formation after minimally invasive surgery may be valid.²⁶ Most importantly, in this study, we demonstrated that in cases that were completed using minimally invasive techniques, the complication rate was only 7.1%, a number similar to outcomes of other series of cases performed in a surgically naïve retroperitoneum. These findings may justify our approach of LRI after open surgery to determine if the potential benefits of minimally invasive surgery apply to patients needing reoperation in the ipsilateral retroperitoneum.

Acknowledging the hazards of repeated retroperitoneal surgery, the options for the management of recurrent or *de novo* renal masses remain identical to the management of the sporadic renal mass: total or partial nephrectomy, ablation, or observation.²⁷ At our institution, every attempt is made to avoid total nephrectomy wherever possible. Renal tumor ablation is discussed if the recurrence is solitary and peripheral, or if the patient has already undergone multiple ablations with good oncologic outcomes. Most patients, however, are steered toward nephron-sparing surgery, which is supported by our previous reports of encouraging oncologic outcomes

and challenges associated with surgeries after previous ablation.^{4,28,29}

A nephron-sparing approach in the hereditary kidney cancer population may be particularly crucial, because many of these patients possess some degree of or are at risk for development of renal insufficiency and often need ipsilateral reintervention. In the present study, we did not detect a statistically significant difference in preoperative and postoperative changes in creatinine level, eGFR, or ipsilateral renal scan function between the MIPN and LRFA groups; however, the small number of patients may have been underpowered to detect these differences. Similar to our published series of repeated OPN, minimally invasive nephron-sparing surgery preserves the vast majority of preoperative function.^{3,4,30}

As urologists continue to expand the role of nephron-sparing surgery, the management of local recurrences may no longer mandate open nephrectomy. This study may be useful for urologic surgeons dealing with the challenges of local recurrences and repeated retroperitoneal interventions. While the present study was conducted on patients with primarily hereditary multifocal RCC, much of our current knowledge about renal carcinoma recurrence, management, and reoperative renal surgery has been extrapolated from this population. Therefore, the data from this study may be directly applicable in the treatment of patients in whom recurrent tumors develop in the setting of previous open ipsilateral surgery.

The present study has several inherent limitations. It is a retrospective review, and our sample size is relatively small. Oncologic and renal functional outcomes are presented at early follow-up. In addition, numerous factors were considered in the choice for nephron-sparing approaches and likely introduced a significant selection bias. Our team's experience and familiarity with reoperative renal surgery may have influenced our outcomes. Despite several drawbacks of this study, this is the largest series of laparoscopic renal interventions after previous open retroperitoneal surgery describing perioperative, functional, and oncologic outcomes. With increased use of the nephron-sparing approach worldwide, our findings may become applicable to a much larger number of patients and urologic surgeons when repeated renal intervention is needed.

Conclusions

LRI after previous open ipsilateral surgery is feasible and safe in selected patients. Complication rates in cases completed laparoscopically appear similar to rates in surgically naïve patients. Repeated MIPN carries the highest risk of operative conversion among groups. Appropriate patient selection is paramount for successful outcomes of laparoscopic re-intervention after previous open retroperitoneal surgery. Renal functional and oncologic outcomes are encouraging at early follow-up.

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Disclosure Statement

No competing financial interests exist.

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Abbreviations Used

BMI = body mass index
 LPN = laparoscopic partial nephrectomy
 LRFA = laparoscopic radiofrequency ablations
 LRI = laparoscopic renal interventions
 LTN = laparoscopic total nephrectomy
 MIPN = minimally invasive partial nephrectomy
 OPN = open partial nephrectomy
 RAPN = robot-assisted laparoscopic partial nephrectomy
 RCC = renal-cell carcinoma