

# COMPLEX LAPAROSCOPIC PARTIAL NEPHRECTOMY FOR RENAL HILAR TUMORS

KAREN REISIGER, RAMAKRISHNA VENKATESH, ROBERT S. FIGENSHAU,  
K. TY BAE, AND JAIME LANDMAN

## ABSTRACT

**Objectives.** To evaluate our experience with laparoscopic partial nephrectomy (LPN) for tumors located adjacent to the renal hilum. Continued advances in laparoscopic technology and technique have made LPN feasible for increasingly anatomically complex tumors.

**Methods.** A retrospective chart review was performed of all patients who underwent LPN at Washington University. We identified 8 patients who had undergone LPN between December 2001 and September 2004 for hilar tumors that were defined as those located within 5 mm of the renal hilar vessels. The data were retrospectively analyzed for parameters, including operative time, morbidity, and postoperative course.

**Results.** LPN was successfully completed in all 8 patients without conversion to an open or hand-assisted approach. The indication for nephron-sparing surgery was elective in 6 patients and imperative in 2. The mean operative time was 3.0 hours (range 2.5 to 3.5), and the mean estimated blood loss was 188 mL (range 30 to 700). All patients had negative margins on the final pathologic examination. No intraoperative complications occurred. Nine postoperative complications developed in 6 patients. They included hemorrhage in 1, fever in 1, ileus in 1, urinary tract infection in 1, urine leak in 4, and transient postoperative neuropathy in 1 patient.

**Conclusions.** With adequate laparoscopic experience, LPN for hilar tumors is a reasonable surgical option. In our experience, the procedure was associated with an increased risk of urine leak. Preoperative placement of a ureteral catheter to help delineate collecting system violations and routine postoperative stenting may reduce the incidence of this complication. UROLOGY 65: 888–891, 2005. © 2005 Elsevier Inc.

Historically, open radical nephrectomy has been the treatment of choice for renal masses,<sup>1</sup> with nephron-sparing surgery reserved for imperative indications.<sup>2</sup> However, successful outcomes with nephron-sparing surgery have prompted its application to patients with nonimperative indications. Open partial nephrectomy has evolved into an accepted standard of care for the treatment of small renal tumors (less than 4 cm), because the procedure has demonstrated equivalent recurrence-free survival compared with radical nephrectomy in properly selected patients.<sup>3–7</sup>

Preliminary efforts to perform laparoscopic partial nephrectomy (LPN) evolved in an attempt to

improve patient outcome, morbidity, and mortality. LPN initially entailed wedge resection of small, peripheral, exophytic tumors. As the technology and surgical expertise have improved, the indications for LPN have expanded.<sup>8</sup>

To date, most LPN series have focused on establishing efficacy for the treatment of easily accessible peripheral tumors, but little has been written on the outcomes of patients with central or hilar tumors complicating the procedure. The difficulty and increased incidence of complications associated with treating central tumors has been documented with open partial nephrectomy.<sup>9,10</sup> We reviewed our experience with LPN of masses located within 5 mm of the renal hilum.

## MATERIAL AND METHODS

The Washington University School of Medicine Human Studies Committee provided permission for review of the patient charts. We performed a retrospective chart review of all patients with hilar tumors undergoing LPN and collected relevant preoperative, operative, and follow-up data. Between

*From the Division of Urology and Department of Radiology, Washington University School of Medicine, St. Louis, Missouri*

*Reprint requests: Jaime Landman, M.D., Department of Urology, Columbia University Medical Center, 161 Fort Washington Avenue, Room 1153, New York, NY 10032-3713. E-mail: landmanj@yahoo.com*

*Submitted: August 10, 2004, accepted (with revisions): November 17, 2004*

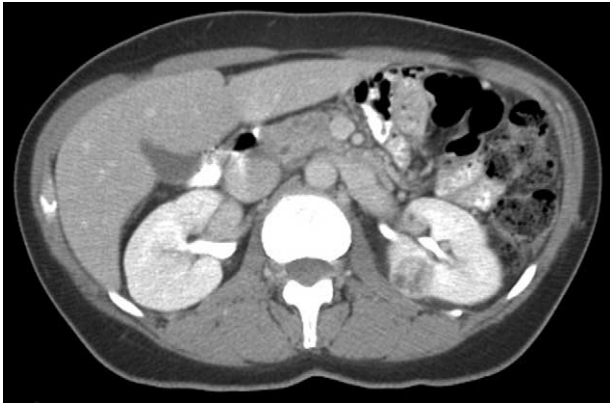


FIGURE 1. View of 2.1-cm left kidney mass within 2 mm proximity to hilar vessels.

December 2001 and September 2004, 136 patients underwent LPN, with 8 (6%) identified as having undergone LPN for hilar tumors by three surgeons. One surgeon had completed the 5 most recent cases and three surgeons had completed 1 case each. Hilar tumors were defined as those within 5 mm of the hilar vasculature as determined by preoperative computed tomography (CT) or magnetic resonance imaging (MRI). A representative tumor is depicted in Figure 1.

The preoperative evaluation for each patient incorporated a standard staging workup, including contrast-enhanced CT or MRI to evaluate the standard staging and renal lesion parameters, including location, size, depth, and relation to hilar vessels and collecting system. All patients provided informed consent regarding the risks of LPN. Specifically, the risks associated with surgery in close proximity to hilar structures, including vascular compromise and urine leakage, were discussed. Each patient was also provided an explanation of the surgical alternatives, including open and laparoscopic radical nephrectomy, open partial nephrectomy, and ablative technologies.

Both retroperitoneal ( $n = 3$ ) and transperitoneal ( $n = 5$ ) approaches were used. The decision of the optimal approach was made by each surgeon after consideration of the individual patient characteristics such as previous abdominal surgery, anatomic tumor location, and a previous history of peritonitis.

LPN was completed using a standard transperitoneal or retroperitoneal approach. Preoperative retrograde externalized ureteral catheters were placed in 2 patients to facilitate delineation of the collecting system during renal reconstruction.

The technical challenge associated with hilar tumors necessitated precise and extensive dissection of the hilar vessels, and clamping of the main renal artery with bulldog clamps was performed in 7 patients (88%). In 3 patients, bulldog clamping of the renal vein was also performed. To facilitate tumor excision, extensive hilar dissection was necessary in all cases. After extensive dissection, selective segmental artery ( $n = 4$ ) and vein ( $n = 2$ ) ligation was performed in 4 patients (50%). In these 4 patients, the tumors were immediately adjacent to segmental vessels, and complete excision with a negative tumor margin was possible only by selective ligation of the segmental vasculature. After hilar clamping, the tumors were resected using either the harmonic scalpel or cold scissors. We initially used the harmonic scalpel early in the series but found that cold scissors improved excision because of the curvature of the scissor blades and better appreciation of normal renal parenchymal tissue under vascular control. Intraoperative ultrasonography was used in 2 patients to delineate the local anatomy and the tumor depth. Collecting system entry was apparent in 5 of the 8 patients. The collecting system closure was completed with interrupted or figure-of-eight Vicryl sutures using an intracorporeal suturing technique.

Multiple modalities were used for hemostasis, as per surgeon preference. Hemostasis was achieved using fibrin glue in all patients, Surgicel in 3, the Floating Ball (TissueLink, Dover, NH) monopolar device in 4, argon beam coagulation in 2, and Surgicel with bolstering sutures in 3 patients. The decision of what combination of closure and hemostatic techniques was used was partially dependent on when each case was performed. Early in the series, argon beam and fibrin glue were the predominant methods of closure. More recently, we have been using the Floating Ball monopolar device for vascular control combined with intracorporeal suturing over bolsters.

Postoperative indwelling double-J stents were deployed in 3 patients with recognized violation of the collecting system. Intrarenal cooling was used for parenchymal hypothermia in 1 patient early in the series.<sup>11</sup> Extensive laparoscopic experience has allowed our ischemic times to average 25 minutes (maximum 34). As such, we believe that parenchymal hypothermia is not required for most patients. All tumors were removed intact in an EndoCatch (Ethicon Endosurgery, Cincinnati, Ohio) entrapment sack. Indigo carmine was not administered in any of our patients.

The operative time, intraoperative and postoperative complications, estimated blood loss, postoperative analgesic requirements, length of hospital stay, time to oral intake, and time to ambulation were all recorded. The data were compared with those of published series of partial nephrectomies.

Patient follow-up was as per our clinical study protocols with CT or MRI on postoperative day 1. Subsequently, patients underwent contrast-enhanced CT or MRI every 3 months for the first year, and then every 6 months for 5 years thereafter.

## RESULTS

Of the 8 patients, 4 were women and 4 were men, with an average age of 52 years (range 36 to 68). The average tumor size was 1.60 cm (range 0.9 to 2.7), and all were within 5 mm of the hilar blood vessels. Five of the tumors had been found incidentally, and four were characterized as endophytic. All the lesions had components on preoperative imaging that enhanced and were thus suspicious for renal cell carcinoma. The final pathologic examination revealed 6 patients with renal cell carcinoma (4 with a clear cell variant and 2 with a papillary variant), 1 with oncocytoma, and 1 with a benign cyst with chronic inflammation.

All eight laparoscopic hilar partial nephrectomies were successfully completed without conversion to a hand-assisted or an open approach, five using a transperitoneal approach and three using a retroperitoneal approach. The mean operative time was 3.0 hours (range 2.5 to 3.5), with a mean warm ischemia time of 26.0 minutes (range 20 to 34). The hilar vessels were exposed in all procedures, and hilar vascular clamping was performed during resection of seven of eight masses. Four of these cases required bulldog clamps only on the artery, and the other three had bulldog clamps on both the artery and the vein. The estimated blood loss was 188 mL (range 30 to 700). The 1 case without hilar clamping resulted in the 700-mL blood loss.

All patients resumed oral intake and ambulated within 24 hours after surgery. The mean analgesic

requirement was 26 mg MSO<sub>4</sub> Eq (range 0 to 90). The mean hospital stay was 3.9 days (range 2 to 8). Patients returned to partial activity within the first week and enjoyed full activity at 4 weeks. No significant difference was observed between the preoperative and postoperative creatinine (0.9 and 1.1 mg/dL, respectively;  $P = 0.057$ ). No patient required temporary dialysis.

No intraoperative complications occurred. Nine postoperative complications developed in 6 patients. One patient with an estimated blood loss of 700 mL required a postoperative transfusion of 2 U packed red blood cells. One human immunodeficiency virus-positive patient experienced an ileus and postoperative fever without obvious etiology despite a thorough evaluation. The fevers resolved with empiric antibiotics by postoperative day 5. One patient developed a urinary tract infection on postoperative day 21 that resolved with oral antibiotics.

Four patients experienced postoperative urine leaks. One small urine leak resolved with observation and two others resolved after temporary double-J stent decompression. The last of the 4 patients developed an infected urinoma despite double-J stent decompression and percutaneous drainage. After 2 weeks with persistent leakage, the patient requested and underwent laparoscopic total nephrectomy, which demonstrated no evidence of disease on the final pathologic examination. The first 3 patients experiencing urine leaks were the first 3 patients in our series, suggesting that this high leakage rate was associated with our learning curve. In addition, the final patient in the series had had a significant collecting system disruption, but did not develop a urine leak. Preliminary data analysis in this patient population suggested an unacceptably high rate of leakage. For this reason, we used preoperative pigtail catheter placement with retrograde saline injection during the case to delineate any collecting system violation. After six figure-of-eight sutures, retrograde saline injection demonstrated no leak. At the pigtail catheter exchange to an indwelling double-J stent on the third postoperative day, retrograde pyelography revealed no leakage.

All patients had negative margins on the final pathologic examination. The mean tumor margin was 2.1 mm (range 1 to 5). The small size of the negative margin in these cases was due to the proximity of the renal vasculature. Histopathologic examination revealed renal cell carcinoma in 6 patients. Two were grade II-IV papillary RCC, two were grade II-IV clear cell RCC, one was grade III-IV clear cell RCC, and one was grade IV-IV clear cell RCC. One patient had an oncocytoma, and one had a benign cyst with chronic inflammation. At the final pathologic examination, the average tumor size

was 1.7 cm. At a mean follow-up period of 10.2 months, no patient had had disease recurrence.

## COMMENT

Technological advancements and increased surgical expertise have allowed the treatment of larger and anatomically more complex renal tumors with LPN.<sup>2,8,12-14</sup> The prior technical limitations of parenchymal reconstruction, hemostasis, and renal ischemia are being rapidly addressed through application of novel technology and improved laparoscopic surgical techniques.

Given the technically challenging nature of hilar LPN, considerable laparoscopic expertise is essential to minimize the ischemic time. After hilar control, expeditious and precise tumor resection, collecting system closure, and parenchymal reconstruction are essential for preserving renal function. A bloodless field, achieved by clamping of the renal pedicle, is essential to successfully achieve these surgical objectives.

In complicated hilar tumors, the proximity of the renal vasculature increases the risk of hemorrhage, necessitating surgeon familiarity with laparoscopic hemostatic techniques. A recent report of hand-assisted laparoscopic partial nephrectomy of central tumors without hilar vessel clamping revealed a mean estimated blood loss of 894 mL, with 50% of patients requiring blood transfusion.<sup>15</sup> In the current series, the only case with a blood loss of greater than 200 mL was in a patient in whom hilar clamping was not used. This patient experienced a 700-mL estimated blood loss and required transfusion of 2 U packed red blood cells in the postoperative period.

LPN has compared favorably with open partial nephrectomy in a number of recently published series.<sup>13,16</sup> Gill and associates<sup>17</sup> recently reported favorable parameters, including surgical time, blood loss, postoperative analgesia, hospital stay, and convalescence, for the laparoscopic approach in their series of 200 patients undergoing either open partial nephrectomy or LPN. Only the ischemic time was increased to 28 minutes in the LPN cases versus 18 minutes in the open cases.<sup>17</sup>

The number of incidentally discovered renal tumors continues to rise with increased use of imaging technologies. In the current series, 6 of our 8 patients' tumors (75%) were incidental findings, as were 35% of renal cell carcinomas in young patients in a recent report.<sup>18</sup> These tumors are often small when detected and amenable to nephron-sparing surgery. In our study, the final histopathologic findings of 6 patients revealed renal cell carcinoma; one was a benign cyst with chronic inflammation, and 1 patient had an oncocytoma (29% benign). Recent reviews have revealed that

20% to 30% of renal masses less than 4 cm are benign, and the investigators recommended that nephron-sparing surgery be used whenever possible for this size lesion.<sup>18,19</sup>

Our postoperative complication rate of 88% (7 of 8 patients) was greater than that seen with LPN for tumors in other less challenging locations. Four (44%) of the nine complications were self-limiting (ileus, fever, neuropathy, and small urinoma). The most common and significant complication was postoperative urine leakage, with all 4 patients whose collecting systems were entered during surgery experiencing urine leak. One patient proceeded to develop an infected urinoma despite stenting and percutaneous drainage, which eventually led to elective complete nephrectomy. Our consistent experience with postoperative urine leak suggests that routine postoperative stenting should be performed for patients undergoing hilar LPN.

It is important to note that partial nephrectomy of complex hilar tumors has a high rate of urine leakage even with the open surgical approach. Black and colleagues<sup>9</sup> reported a 27% urinary fistula rate in patients undergoing open partial nephrectomy for centrally located tumors. Hafez and associates<sup>10</sup> reported a urinary fistula rate of 14% after open partial nephrectomy for centrally located tumors in the Cleveland Clinic experience. In a recent series of hand-assisted laparoscopic partial nephrectomies, 3 (38%) of 8 patients with central tumors developed urinary leaks.<sup>15</sup>

After preliminary review of the data from the current study, we have changed our current practice with hilar renal masses. Presently, in cases of hilar LPN, preoperative ureteral catheters are placed to help delineate defects in the collecting system using retrograde saline infusion after parenchymal transection. Additionally, postoperative stenting and local drainage are routinely used. The last case in the present series involved significant violation of the renal collecting system that was closed with six figure-of-eight sutures. This patient had undergone preoperative ureteral catheter placement and postoperative stenting and had no urinary leakage.

Overall, despite all complications, our patients recovered quickly from LPN and were able to preserve maximal renal tissue while maintaining negative margins on the final pathologic examination. No positive margins were found on the final histopathologic examination, and none of the patients in the current series had experienced recurrence of renal cell carcinoma in the 11.3-month average follow-up period.

## CONCLUSIONS

With sufficient laparoscopic experience, LPN for hilar tumors is a reasonable surgical option, but is

associated with an increased risk of urine leak. Preoperative placement of a ureteral catheter to help delineate collecting system violations and routine postoperative stenting may reduce this complication.

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