Laparoscopic Partial Nephrectomy in Solitary Kidney

Inderbir S. Gill,* Jose R. Colombo, Jr., Alireza Moinzadeh, Antonio Finelli, Osamu Ukimura, Kay Tucker, Jihad Kaouk and Mihir Desai

From the Section of Laparoscopic and Robotic Surgery, Glickman Urological Institute, Cleveland Clinic Foundation, Cleveland, Ohio

Purpose: We report our experience with LPN for tumor in a solitary kidney.

Materials and Methods: Of 430 patients undergoing LPN since February 1999 at our institution 22 (5%) underwent LPN for tumor in a solitary kidney, as performed by a single surgeon. The laparoscopic technique that we used duplicated open principles, including hilar clamping, cold cut tumor excision and sutured renal reconstruction.

Results: Mean tumor size was 3.6 cm (range 1.4 to 8.3, median 3 cm), median blood loss was 200 cc (range 50 to 500), warm ischemia time was 29 minutes (range 14 to 55), total operative time was 3.3 hours (range 2.2 to 4.5) and hospital stay was 2.8 days (range 1.3 to 12). Two cases (9%) were electively converted to open surgery. Pathological findings confirmed renal cell carcinoma in 16 patients (73%) with negative surgical margins in all those with LPN. Major complications occurred in 3 patients (15%) and minor complications developed in 7 (32%). Median preoperative and postoperative serum creatinine (1.2 and 1.5 mg/dl) and estimated glomerular filtration rate (67.5 and 50 ml per minute per 1.73 m^2) reflected a change of 33% and 27%, respectively, which appeared proportionate to the median amount of kidney parenchyma excised (23%). One patient (4.5%) required temporary hemodialysis. At a median followup of 2.5 years (range 0.5 to 4.5) cancer specific and overall survival was 100% and 91%, respectively. No patient with LPN had local or port site recurrence, or metastatic disease.

Conclusions: LPN can be performed efficaciously and safely in select patients with tumor in a solitary kidney. To our knowledge we present the largest series in the literature. Advanced laparoscopic experience and expertise are necessary in this high risk population.

Key Words: kidney, abnormalities, nephrectomy, laparoscopy, kidney neoplasms

Tumor in an anatomically or functionally solitary kidney is an absolute indication for nephron sparing surgery, provided that such surgery is technically feasible, and oncologically and functionally efficient. Complete tumor excision with maximal nephron preservation poses special challenges in this setting. Until recently partial nephrectomy in patients with tumor in a solitary kidney has been the exclusive preserve of open surgery with adequate renal functional and oncological outcomes.[1–4]

In the last 5 years minimally invasive techniques have entered the realm of nephron sparing surgery. Initially limited to smaller exophytic tumors,[5] LPN has recently been applied to more technically demanding cases involving larger or hilar tumors.[6,7] LPN for tumor in a solitary kidney imposes unique demands on minimally invasive surgery in regard to preoperative planning, intraoperative execution and postoperative management.[8,9] To our knowledge we present the largest series of LPN for tumor in a solitary kidney.

MATERIALS AND METHODS

Since February 1999, we have performed LPN for tumor in 430 patients at our institution. Patient data, which were entered and maintained prospectively in our LPN registry, were evaluated for this study with Institutional Review Board approval. Of these 430 patients 22 (5%) underwent LPN for tumor in a solitary kidney. Indications for LPN in this study were a radiologically suspicious (defined as any enhancement with intravenous contrast medium greater than 20 HU), organ confined renal tumor that was deemed technically feasible by the primary surgeon (ISG). Laparoscopic technical feasibility was primarily based on tumor location, the depth of parenchymal infiltration and proximity to hilar vessels. Tumor size per se was not a primary consideration in this absolute setting for nephron sparing surgery. All patients underwent 3-dimensional computerized spiral tomography (3 mm cuts) with video reconstruction at our institution to facilitate preoperative planning. Estimated GFR was calculated using the formula, GFR = [(140 – age in years) × weight in kg]/(72 × serum creatinine in mg/dl).

Our laparoscopic technique has been described in detail previously.[6] Briefly, the renal hilar vessels were mobilized, the kidney was defatted except for maintaining fat directly over the tumor and flexible contact ultrasonography was performed to evaluate tumor characteristics and score an adequate resection margin. The hilum was clamped en bloc and the tumor was excised in an almost bloodless field with cold endoscopic shears. Any pelvicaliceal entry was precisely identified and suture repaired, followed by hemostatic renorrhaphy over a Surgicel™ bolster. Emphasis was placed on adequate intraoperative hydration and robust diuresis with timed doses of mannitol (12.5 gm intravenously at the beginning of dissection and prior to hilar unclamping) and

Submitted for publication April 8, 2005.
Study received Institutional Review Board approval.
* Correspondence and requests for reprints: Section of Laparoscopic and Robotic Surgery, Glickman Urological Institute, Cleveland Clinic Foundation, 9500 Euclid Ave., A100, Cleveland, Ohio 44195 (telephone: 216-445-1530; FAX: 216-445-7031; e-mail: gilli@ccf.org).

TABLE 1. *Baseline demographics*

Mean age ± SD (range)	62 ± 14.8 (35–87)
Median American Society of Anesthesiologists score (range)	2.7 (2–3)
No. men (%)	11 (50)
No. side (%)	13 (59)
Mean cm tumor size ± SD (range)	3.05 ± 1.6 (1.4–8.3)
No. tumor size 4 cm or greater (%)	6 (27)
No. solitary kidneys with multiple renal vessels (%)	5 (22)
No. of solitary kidney etiology (%):	
Radical nephrectomy for RCC	15 (68)
Contralat atrophic kidney	4 (18)
Nephrectomy for stone disease	1 (4.5)
Donor nephrectomy	1 (4.5)
Congenital solitary kidney	1 (4.5)
No. tumor location (%):	
Upper pole	4 (18)
Mid kidney	10 (45)
Lower pole	8 (36)
Hilum	5 (23)
Central region	10 (45)
Peripheral region	12 (55)

TABLE 2. *Perioperative data*

No. transperitoneal approach (%)	12 (55)
Median ml blood loss (range)	200 (50–500)
No. pelvicaliceal repair (%)	14 (63)
Median mins warm ischemia time (range)	29 (14–55)
Median hrs operative time (range)	3.3 (2.2–4.5)
Median % kidney excised (range)*	23 (10–65)
No. FloSeal® used (%)	7 (31)
Median ml intraop urine output (range)	543 (40–5,400)
Median days hospital stay (range)	2.8 (1.3–12)

* Data available on 13 patients.

furosemide (10 to 20 mg prior to unclamping). Postoperative followup comprised serum creatinine, GFR estimation and radionuclide renal scan at 1 month, and abdominal computerized tomography or magnetic resonance imaging at 6 months and yearly thereafter in patients with pathologically confirmed renal cancer. Followup was performed prospectively and kept current with ongoing contact with the patient, family and/or referring physician.

RESULTS

A total of 22 patients underwent LPN for tumor in a solitary kidney (table 1). There were 11 males and 11 females with a median age ± SD of 62 ± 14.8 years (range 35 to 87). On preoperative computerized tomography median tumor size was 3 ± 1.6 cm (range 1.4 to 8.3). In 6 patients (27%) the tumor was 4 cm or greater (see figure). No patient had multifocal tumors. Preoperatively serum creatinine was 1.2 mg/dl (normal 0.8 to 1.4) and median estimated GFR was 67.5 ml per minute per 1.73 m^2. Eight patients (37%) presented with baseline renal dysfunction, defined as serum creatinine greater than 1.4 mg/dl. The commonest etiology of solitary kidney was contralateral radical nephrectomy for cancer in 15 patients (68%), while 4 (18%) had an atrophic, nonfunctioning contralateral kidney. The transperitoneal laparoscopic approach was used in 12 patients (55%) and the retroperitoneal approach was used in 10 (45%).

LPN was performed with hilar clamping in all patients with a median warm ischemia time of 29 minutes (range 14 to 55) (table 2). Pelvicaliceal entry and suture repair were performed in 14 patients (63%). Median estimated blood loss was 200 cc (range 50 to 500), total operative time was 3.3 hours (range 2.2 to 4.5) and hospital stay was 2.8 days (range 1.3 to 12). No patient who underwent laparoscopy required blood transfusion.

Elective conversion to open partial nephrectomy was performed in 2 patients (9%). In 1 patient with a history of post-chemotherapy open retroperitoneal lymph node dissection for testicular cancer dense preexisting peri-vena caval surgical scarring in the renal hilar region precluded adequate dissection and clamping of the right renal hilum. In this patient even after elective conversion to open partial

A, 79 year-old male had solitary right kidney with 5.5 cm lower pole renal tumor abutting central sinus and inferior calices. Surgical history was significant for multi-organ cancer, including left radical nephrectomy for kidney disease, prostate cancer treated with seed implantation, testicular cancer treated with orchiectomy, and whole abdominal radiotherapy and colon cancer treated with open surgical colectomy and chemotherapy. Hypertension history had required 2 anti-hypertensive drugs. Preoperative serum creatinine 1.6 mg/dl and aortic calcification on computerized tomography raised suspicion for concomitant right renal artery stenosis. *B*, aortogram reveals proximal renal artery stenosis with measured pressure gradient greater then 10% across stenotic segment. *C*, percutaneous renal artery balloon angioplasty with stenting was performed, followed 1 month later by laparoscopic transperitoneal lower pole right partial nephrectomy. Warm ischemia time was 18 minutes, blood loss was 100 cc, operative time was 2 hours and intraoperative urine output was 1.2 l. Hospital stay was 5 days without any complications. Pathological findings confirmed clear cell RCC with negative parenchymal margins. Postoperatively serum creatinine peaked at 2.1 mg/dl and stabilized at 1.8 mg/dl at hospital discharge.