Outcomes of Laparoscopic Partial Nephrectomy after Fellowship Training

Satyan K. Shah, MD, Surena F. Matin, MD, Eric A. Singer, MD, Louis Eichel, MD, Hyung L. Kim, MD

ABSTRACT

Background and Objectives: Experienced surgeons at select high-volume centers have reported favorable outcomes of laparoscopic partial nephrectomy (LPN) in their contemporary experience. However, it is unclear whether recently fellowship-trained surgeons can replicate such outcomes. We evaluated LPNs performed by 3 surgeons in their initial years of independent practice following laparoscopic fellowship training.

Methods: Prospectively maintained databases were queried for LPNs performed during the first 3.5 years of practice. Intraoperative parameters, oncological efficacy, and postoperative complications were analyzed.

Results: Of 138 total LPNs (76 left, 62 right), the mean patient age was 57 years, mean tumor size was 2.52 cm, and mean depth of invasion was 1.68 cm. Mean OR time was 252 minutes, mean warm ischemia time (WIT) was 26 minutes, and mean estimated blood loss (EBL) was 202 mL. Complications occurred in 7 patients (5%), and conversions occurred in 9 patients (7%). Comparison of the first 15 vs. the last 15 cases demonstrated a significant reduction in mean OR time (204 min vs. 253 min, P = 0.007), and mean WIT (24 min vs. 32 min, P < 0.001). No significant change was demonstrated for tumor size (2.6 cm vs. 2.4 cm, P = 0.390) or EBL (226 mL vs. 220 mL, P = 0.922).

Conclusion: Newly fellowship-trained surgeons performing LPN achieve initial outcomes comparable to those reported by highly experienced surgeons. Further experience reduced total operative and warm ischemia times.

Key Words: Kidney, Nephrectomy, Laparoscopy, Fellowship.

INTRODUCTION

Laparoscopic partial nephrectomy (LPN) is a technically challenging procedure. Surgeons performing LPN must not only possess advanced intracorporeal suturing skills, but must also operate efficiently under the time constraints of warm ischemia. When first reported in the 1990s, LPN was associated with high complication rates, including hemorrhage, urinary fistula, and open conversion. However, contemporary reports from experienced surgeons document more favorable outcomes.

Surgeons who have received fellowship training at high-volume centers with extensive LPN experience are performing LPNs early in their careers. However, limited outcome data exist for these surgeons, and it is unclear whether, immediately after training, they achieve results comparable to those of their mentors. In addition, because robot-assisted partial nephrectomy is being investigated and even promoted as a procedure for surgeons without formal laparoscopic training, it is critical to better define skills obtainable from traditional laparoscopic training programs. This study documents the outcomes of LPN as performed by 3 surgeons in the initial years of independent practice following fellowship training.

MATERIALS AND METHODS

Three prospectively maintained renal tumor databases were queried for LPNs performed during the first 3.5 years of practice. All primary surgeons (SFM, LE, HLK) completed urologic fellowships between 2001 and 2004. Each had trained with surgeons experienced in performing LPNs and participated in at least 10 LPNs during their fellowship. Although the level of participation varied during each case, typically as fellows, these surgeons mobilized the kidney and hilum laparoscopically while their mentors performed the tumor excision and renorrhaphy.

Patients

Demographic data extracted for all patients included age, sex, and laterality. Operative data included total operative time, warm ischemia time (WIT), tumor size, depth of invasion, estimated blood loss (EBL), reason for conversion, and postoperative complications. Tumors seen abut-
ting the collecting system or renal hilum on CT scan were considered to be central.

**Surgical Technique**

All cases by HLK were performed transperitoneally using a 4-port to 5-port technique. Intraoperative ultrasound was routinely used to confirm tumor location. Tumor excision and renorrhaphy was performed under warm ischemic conditions by placing a laparoscopic satinsky clamp on the renal artery only. Cold scissor tumor excision allowed for visual confirmation of a grossly negative margin. Repair of the tumor bed was accomplished by using a single layer of 0-vicryl sutures on CPX needles, placed in a figure-of-8 fashion and held in place with Lapra-Ty clips (Ethicon, Piscataway, NJ). Each stitch was passed under the entire tumor bed, thereby closing the collecting system and achieving hemostasis simultaneously; no bolsters were used.

The LPN technique for SFM has been previously described. Briefly, all cases were performed transperitoneally except for lower pole or posterior renal masses that were approached retroperitoneally. Dedicated laparoscopic intraoperative ultrasound was performed in all cases. The renal hilum was routinely clamped. Suture repair of the defect was performed over a Fibrillar bolster and Surgifoam Powder (Ethicon, Piscataway, NJ).

LE performed LPN primarily using a transperitoneal or retroperitoneal pure laparoscopic approach. In select cases, a hand-assisted approach was preferred. In all cases, the hilum was controlled by using a laparoscopic bulldog clamp on the renal artery under warm ischemic conditions. Tumors were excised using scissors without cautery. The tumor bed was coagulated with a floating ball electrode (Endo FB3.0) (Salient Surgical Technologies, Dover, NH). When necessary, the collecting system was closed by using 3–0 absorbable suture on an SH needle. The tumor bed was then covered with a layer of Surgifoam (Ethicon, Piscataway, NJ). Renorrhaphy was then performed using Surgicel bolsters held in place with 0–0 absorbable sutures on a CT-1 needle secured by Lapra-Ty clips (Ethicon, Piscataway, NJ).

**Comparisons and Statistical Analysis**

Data regarding intraoperative parameters, oncological efficacy, and postoperative complications were analyzed collectively with reported means representing the average of all surgeons at each case number. Because cases performed were not equal for all surgeons, some means represented the average of data for fewer than 3 surgeons. Outcomes were analyzed as a function of case number and plotted graphically. Fisher's exact test was used to compare proportions, and the Student t test was used to compare means. P values <0.05 were considered statistically significant.

**RESULTS**

A total of 138 LPNs (76 left, 62 right) were performed. Females accounted for 48 (35%) of the 136 patients (2 patients had staged bilateral LPNs). The primary surgeon was HLK in 60, SFM in 60, and LE in 18. Mean patient age was 57 years (range, 29 to 91), mean tumor size was 2.52 cm (range, 0.6 to 7), mean depth of invasion was 1.68 cm (range, 0.4 to 3.9), and 28 (20%) tumors were central in location.

The majority of procedures (96%) were successfully completed laparoscopically, with mean OR time of 252 minutes (range, 135 to 388), mean WIT 26 minutes (range, 0 to 55), and mean EBL 202 mL (range, 20 to 1700). Complications occurred in 7 patients (5%): hemorrhage requiring transfusion in 3 patients (2%), urinary fistula in 1 patient (1%), rhabdomyolysis that spontaneously resolved without the need for dialysis in 1 patient (1%), pyelonephritis in 1 patient (1%), and injury to the IVC that was repaired laparoscopically in 1 patient (1%). Indications for the 9 conversions included bleeding (3 cases), presence of multiple tumors on intraoperative ultrasound (1 case), significant perirenal fibrosis (3 cases), discovery of segmental renal vein tumor thrombus (1 case), and positive margins on frozen section (1 case). The conversions were to laparoscopic radical nephrectomy (LRN) in 4 cases and open partial nephrectomy (OPN) in 5 cases.

Median length of hospitalization was 2 days. Pathology revealed renal cell carcinoma (RCC) in 99 (72%) patients, and positive surgical margins in 2 patients (1%). At median follow-up of 11 months, no patients had evidence of local recurrence. Both patients with positive surgical margins were followed expectantly. Demographic and surgical parameters are summarized and compared with those of more experienced centers in Table 1.

The influence of case number on 4 operative parameters is summarized in Table 2. With experience, there was a significant reduction in mean OR time (204 min vs. 253 min, P=0.007) and mean WIT (24 min vs. 32 min, P<0.001). However, there was no significant change for mean tumor size (2.6 cm vs. 2.4 cm, P=0.390) or mean EBL (226 mL vs. 220 mL, P=0.922).

To explore the learning curve for LPN, scatter plots were
constructed to demonstrate the relationship between 4 operative parameters and case number (Figure 1). Parameters showing a statistically significant change with increasing experience (OR time and WIT) were fitted with logarithmic curves. Parameters that did not change significantly with increasing case number were fitted with linear regression equations. For EBL, the line showed a negative slope of 1.12 (P=0.39), and for tumor size it showed a positive slope of 0.01 (P=0.06).

DISCUSSION

Contemporary outcomes of LPN have improved significantly since the original description of this operation by Winfield in 1995. Turna and associates recently analyzed more than 500 patients treated with LPN and found a significant reduction in complications with experience, despite treatment of larger and more complex tumors. The authors reported an overall complication rate of almost

---

**Table 1.**

Comparison of Demographic and Surgical Characteristics

| Demographic/Surgical Characteristic | Current Study | Cleveland Clinic | Johns Hopkins |
|-------------------------------------|---------------|------------------|--------------|
| Mean age (years)                    | 57            | 58               | 56           |
| Number cases                        | 138           | 200              | 217          |
| Number left sided (%)              | 76 (55%)      | 108 (54%)        | 102 (47%)    |
| Number females (%)                 | 48 (35%)      | 64 (32%)         | 88 (40%)     |
| Mean tumor size (cm) [range]       | 2.52 [0.6–7]  | 3.0 [0.9–10.3]   | 2.6 [1–10]   |
| Mean OR* time (min)                | 253           | 218              | 204          |
| Mean WIT* (min)                    | 32            | 28               | 26           |
| Mean EBL* (mL)                     | 220           | 295              | 231          |

*OR = operating room; WIT = warm ischemia time; EBL = estimated blood loss.
†Comparing first 15 cases to last 15 cases.

**Table 2.**

Laparoscopic Partial Nephrectomy Operative Parameters as a Function of Experience

| Surgical Parameter          | Cases 1–15 | Cases 16–30 | Cases 31–45 | Cases 46–60 | P Value† |
|-----------------------------|------------|-------------|-------------|-------------|----------|
| Mean tumor size (cm)        | 2.4        | 2.5         | 2.8         | 2.6         | 0.390    |
| Mean OR* time (min)         | 253        | 218         | 204         | 204         | 0.007    |
| Mean WIT* (min)             | 32         | 28          | 26          | 24          | <0.001   |
| Mean EBL* (mL)              | 220        | 295         | 231         | 226         | 0.922    |

*OR = operating room; WIT = warm ischemia time; EBL = estimated blood loss.
†Comparing first 15 cases to last 15 cases.
Kavoussi and associates reviewed 345 patients undergoing LPN and found a 28% complication rate, and 80% of these were deemed minor.

The current study suggests that fellowship training under the tutelage of experienced surgeons allows urologists to achieve favorable outcomes in their initial years of independent practice. The positive margin rate (1%), and overall complication rate (5%) are comparable to that reported in other published reports from high-volume surgeons.

The surgeons in the current study had the benefit of using techniques already refined by their mentors. They may also have minimized their complications by using liberal indications for converting to laparoscopic radical nephrectomy (3%) or open partial nephrectomy (4%).

To assess the learning curve for fellowship-trained urologists, the current study examined changes in 4 key operative parameters as a function of case number. The scatter plots and fitted lines in Figure 1 suggest that, for recently
fellowship-trained surgeons, there is in fact a learning curve for LPN with regards to operative time and warm ischemia time. However, both parameters improved quickly, as evidenced by flattening of the fitted curves. Increased experience was associated with an increase in tumor size that was not statistically significant. In contrast, blood loss was minimally affected by increased experience, suggesting that all 3 surgeons largely mastered techniques to minimize blood loss during their fellowship.

Surgeons in this study used intraoperative ultrasound to plan tumor excision and help achieve negative margins. In the current study, use of the equipment and interpretation of images was performed by the operating surgeon without assistance from a radiologist. Intraoperative ultrasound was particularly useful for localizing endophytic tumors and those tumors densely encased in perinephric fat. Comfort with this technology appears to be another benefit of fellowship training.

Although the current study documents the outcomes of LPN by recently fellowship-trained urologists, residents finishing some urology training programs are graduating with similar exposure to LPN. However, caution must be exercised in extrapolating the findings of the current study to residency training. Fellowship provides a dedicated and focused laparoscopy experience and hence a foundation for performing more complex cases after training. This may explain why fellowship-trained surgeons in the current study were able to perform LPNs despite what appears to be limited exposure to the procedure during their training. Further study is needed to define the optimal training needed to perform this procedure.

Other recently fellowship-trained surgeons have also reported favorable outcomes with LPN. Bhayani reported no significant differences in outcomes of his first 25 LPNs compared with his last 25 LPNs, except for length of hospitalization, with an overall complication rate of 16%. Similarly, Weld and associates reported their experience with 60 consecutive LPNs. There were no open conversions, and the urological complication rate was 13.3%. With regard to the learning curve for LPN, Link et al found a trend toward shorter OR times with the increasing number of cases performed similar to the current study.

Favorable outcomes have been reported by recently fellowship-trained surgeons for other complex laparoscopic procedures. Rosser showed that 2 recently fellowship-trained surgeons performing radical prostatectomy within their first year of practice were able to achieve oncological outcomes and complication rates similar to those of more experienced surgeons. With regard to laparoscopic donor nephrectomies, Sajadi and associates showed fellowship training in laparoscopy allowed for favorable operative results of donor nephrectomies and long-term graft survival. Proposed benefits of fellowship training with regard to patient outcomes after laparoscopic gastric bypass include shorter operative times, lower complication rates, and lower mortality rates. These studies suggest that fellowship training places a new surgeon high on the learning curve for complex laparoscopic operations, and allows them to perform these procedures with favorable outcomes.

This study has several limitations. First, it is subject to retrospective bias. Specifically, the study relied on data from surgeons from different institutions, who may have used differing criteria to record and grade complications. Secondly, the study does not have a direct comparison arm, such as a group of surgeons performing LPN without fellowship training. Lastly, the disparity in the case volume between the 3 surgeons and differences in surgical technique could have affected analysis of the learning curve for LPN. Mean values for all surgeons at each case number were used to minimize this effect.

CONCLUSION

Newly fellowship-trained surgeons performing LPN achieve initial outcomes comparable to those reported by highly experienced surgeons. Further experience reduced total operative and warm ischemia times.

References:

1. Turna B, Frota R, Kamoi K, et al. Risk factor analysis of postoperative complications in laparoscopic partial nephrectomy. J Urol. 179(4):1289–1294, 2008; discussion 94–95.
2. Winfield HN, Donovan JF, Lund GO, et al. Laparoscopic partial nephrectomy: initial experience and comparison to the open surgical approach. J Urol. 1995;153(5):1409–1414.
3. Permpongsakosol S, Link RE, Su LM, et al. Complications of 2,775 urological laparoscopic procedures: 1993 to 2005. J Urol. 2007;177(2):580–585.
4. Brown GA, Matin SF. Laparoscopic partial nephrectomy: experience in 60 cases. J Endourol. 2007;21(1):71–74.
5. Simmons MN, Gill IS. Decreased complications of contemporary laparoscopic partial nephrectomy: use of a standardized reporting system. J Urol. 177(6):2067–2073, 2007; discussion 73.
6. Link RE, Bhayani SB, Allaf ME, et al. Exploring the learning curve, pathological outcomes and perioperative morbidity of
laparoscopic partial nephrectomy performed for renal mass. *J Urol.* 2005;173(5):1690–1694.

7. Bhayani SB. Laparoscopic partial nephrectomy: fifty cases. *J Endourol.* 2008;22(2):313–316.

8. Weld KJ, Venkatesh R, Huang J, Landman J. Evolution of surgical technique and patient outcomes for laparoscopic partial nephrectomy. *Urology.* 67(3):502–506, 2006; discussion 6–7.

9. Rosser CJ, Kamat AM, Pendleton J, et al. Impact of fellowship training on pathologic outcomes and complication rates of radical prostatectomy. *Cancer.* 2006;107(1):54–59.

10. Sajadi KP, Wynn JJ, Brown JA. Impact of fellowship training in initiating a laparoscopic donor nephrectomy program. *J Laparoendosc Adv Surg Tech A.* 2007;17(4):425–428.

11. Ballantyne GH, Ewing D, Capella RF, et al. The learning curve measured by operating times for laparoscopic and open gastric bypass: roles of surgeon’s experience, institutional experience, body mass index and fellowship training. *Obes Surg.* 2005;15(2):172–182.

12. Oliak D, Owens M, Schmidt HJ. Impact of fellowship training on the learning curve for laparoscopic gastric bypass. *Obes Surg.* 2004;14(2):197–200.