

Laparoendoscopic single-site surgery of the kidney: an initial experience

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Introduction: Laparoendoscopic single-site surgery (LESS) has emerged as a natural progression from standard laparoscopy toward minimization of surgical morbidity. We present our initial experience with LESS renal surgery in order to assess safety, feasibility, and early postoperative outcomes.

Materials and methods: Patients undergoing LESS renal surgery by a single surgeon from November 2008 to June 2010 were retrospectively identified. Safety, feasibility, and early outcomes were analyzed. Pain parameters were assessed using morphine equivalents used and visual analog pain scores (VAPS).

Results: LESS procedures included 13 radical nephrectomy (1 bilateral), 5 simple nephrectomy (1 bilateral), 2 partial nephrectomy, 2 renal biopsy, and 1 renal cryoablation. Of

17 renal tumors, 15 were renal cell carcinoma and 2 had known renal vein involvement. Mean patient age was 55.4 years and mean BMI was 25.5 kg/m². Mean operative time was 131 minutes (38-230), median estimated blood loss was 50 mL, and median length of stay was 2 days. There was one intraoperative transfusion and one conversion to conventional laparoscopy. The postoperative complication rate was 12% with two Clavien grade > 2 complications. Mean morphine equivalent dose of intravenous narcotics was 21.7 mg, and mean VAPS scores were 4.3, 3.5, and 2.9/10 on POD#0, #1, and day of discharge, respectively.

Conclusions: LESS surgery is safe and feasible for a wide variety of renal surgeries. Despite the selection bias of this early experience, postoperative outcomes and pain scores appear comparable to those reported for standard laparoscopy. Prospective studies comparing LESS to standard laparoscopic renal surgery are needed for definitive assessment.

Key Words: laparoendoscopic single-site, cancer, LESS, laparoscopy, kidney, nephrectomy

Introduction

Minimally invasive renal surgery has progressed rapidly over the past two decades. Driven by an effort to reduce perioperative morbidity and improve cosmesis, many open procedures have been replaced by a laparoscopic or robotic-assisted laparoscopic approach. Studies have clearly demonstrated superiority of laparoscopy versus open surgery for both radical and partial nephrectomy regarding postoperative convalescence and postoperative pain, with no concession in treatment outcomes.^{1,2} Laparoscopic single-site surgery (LESS) advances this trend by reducing the number of incisions for

laparoscopic surgery to one. LESS is the standard nomenclature for this type of procedure as dictated by the Laparo-Endoscopic Single-site Surgery Consortium for Assessment and Research, and has also been proposed by the Urologic NOTES Working Group.^{3,4} Data regarding benefits of LESS in comparison with traditional laparoscopy, however, are in evolution.^{5,6} There are conflicting early reports regarding the benefits of LESS regarding length of stay, postoperative pain, and estimated blood loss.⁷⁻¹⁰ While a prospective randomized trial is needed for definitive assessment, the literature regarding LESS is in a nascent phase and more descriptive studies are needed.

In this report, we present our initial experience with LESS renal surgery for a broad range of benign and malignant processes. Our goals are two-fold; first, to assess the safety and feasibility of these varied LESS renal procedures, and second, to report postoperative outcomes and pain scores as a benchmark for future study.

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Patients and methods

The prospectively maintained Johns Hopkins Minimally Invasive Urological Surgery Database (1994-present) was queried for men undergoing LESS renal surgery. Between November 2008 and June 2010, 23 patients were identified who underwent LESS surgery by a single experienced laparoscopic surgeon and represent the initial experience at our institution. Demographic, perioperative, and pathological data were analyzed. Additionally, morphine equivalents used and visual analog pain scale (VAPS) were assessed postoperatively.

In brief, all procedures were performed using a 2.5 cm periumbilical incision and a custom made port (Triport [Olympus, Center Valley, PA, USA] or SILS port [Covidien, Mansfield, MA, USA]) via a transperitoneal technique. A combination of articulating and straight instruments were utilized with the aid of either a 5 mm bariatric length rigid endoscope or an articulating 5 mm endoscope for visualization. For radical nephrectomy, the initial incision was enlarged at the conclusion of the procedure for intact specimen extraction. Partial nephrectomy did not involve hilar clamping and was performed with the aid of the Habib 4x radiofrequency ablation device which was used to coagulate a margin of normal parenchyma around the renal mass to allow excision of the tumor in a bloodless field.

The chi square test was used to analyze categorical variables, and the Student t-test was used for continuous variables. Statistical analysis was performed using STATA version 11.

Results

A total of 12 men and 11 women with a mean age of 55.4 years (range 18-82 years) underwent transperitoneal LESS renal surgery during the study period. The procedures included radical nephrectomy (n=14), simple nephrectomy (n=6), partial nephrectomy (n=2), renal biopsy (n=2), and renal cryoablation (n=1). Two patients had bilateral surgery including 1 bilateral radical nephrectomy and 1 bilateral simple nephrectomy. LESS surgery was successful in 22 patients without need for additional ports. One simple nephrectomy was converted to a multiport laparoscopic approach to facilitate hilar dissection in a patient with extensive desmoplastic reaction surrounding the renal vessels. This involved placement of a 12 mm lateral port and 5 mm superior port for liver retraction for this right-sided dissection. The mean ASA score was 2.13 (range 1-3, median = 2), and the mean ACE-27 score was 1 (range 1-3, median = 1). Mean BMI was 25.8 kg/m² (range 19.3-38.5 kg/m²) with 4 (17.4%) obese patients (BMI > 30 kg/m²). Demographic data are shown in Table 1.

TABLE 1. Patient Demographics

	no./value	(%/range)
n (patients)	23	
Male sex	12	52.17%
Mean age (yrs)	55.4	(18-82)
Mean BMI (kg/m ²)	25.8	(19.3-38.5)
ASA score (mean)	2.13	(1-3)
ACE score (median)	1	(0-3)
Comorbidities		
Hypertension	14	60.87%
Diabetes	2	8.70%
Smoking Hx	10	43.48%
Prior abdominal surgery	12	52%
Laterality		
Right	11	48%
Left	10	43.48%
Bilateral	2	8.70%

TABLE 2. Perioperative outcomes

	no./value	(%/range)
n (kidneys)	25	
Operative parameters		
Mean operative time (min)	131	(38-230)
Median EBL (mL)	50	(0-500)
Transfusions	1	4.17%
Median LOS (days)	2	(1-14)
Lab values		
Mean preop Hb	13.6	(10.3-17)
Mean 24 hr postop Hb	11.8	(8.8-14.5)
Postop complications		
Total	3	12.00%
Urine leak	0	0%
Clavien grade		
I	1	
II	0	
III	1	
IV	1	
Conversion	1	
Pain		
Mean morphine eq. dose (mg)	21.7	(0-81.6)
VAPS day of surgery	4.3/10	(0-8)
VAPS POD1	3.5/10	(0.2-7.7)
VAPS POD2	3.0/10	(0-5.33)
VAPS POD3	2.0/10	(0-4)

The mean operative time was 131 minutes (range 38-230 minutes). Median estimated blood loss (EBL) was 50 mL (range 0-500 mL) with one intraoperative transfusion. Median length of stay (LOS) was 2 days (range 1-14 days) with no same-day discharges. Mean total morphine equivalent dose for postoperative pain was 21.7 mg (range 0-81.6 mg) over the entire length of stay. Mean VAPS scores were 4.3/10 (range 0-8) on day of surgery, 3.5/10 (range 0-7.7) on POD1, and 2.9/10 (0-7) at discharge. Three (13.0%) patients did not require patient-controlled analgesia (PCA), 18 (78.3%) had PCA discontinued on POD1, and 2 (8.7%) required additional days of IV narcotics. Perioperative data can be found in Tables 2 and 3.

A total of 17 (68.0%) operations were performed for renal masses. Pathological data for the radical nephrectomies, partial nephrectomies, and cryoablation showed a mean pathological tumor size of 5.2 cm (range 2.1 cm-8.5 cm), 4.5 cm (range 4.2 cm-4.7 cm), and 1.5 cm respectively. There were 15 renal cell carcinomas (6 clear cell, 5 papillary, 2 mixed, 2 chromophobe), 1 oncocytoma, and 1 angiomyolipoma. One partial nephrectomy

specimen (angiomyolipoma) had a focal positive margin. Pathological data is presented in Table 4.

Three postoperative complications occurred at a mean follow up of 6 months. One patient required a Foley catheter for urinary retention (Clavien I); one patient underwent laparoscopic exploratory laparotomy for small bowel obstruction three weeks following surgery (Clavien III); one patient on chronic steroids for renal transplantation suffered from a severe ileus culminating in a fascial dehiscence on POD#9 requiring emergent operative intervention (Clavien IV).

Overall, 8 (34.8%) patients had severe systemic disease according to ASA class (ASA 3). Five (21.7%) of these 8 also had "moderate to severe decompensation" as categorized by an ACE-27 score of 2 or 3. Stratifying by severity, patients with an ASA score of 3 had a non-significant, increased overall complication rate as compared to patients with an ASA score of 1 or 2 (37.5% versus 6.67%, $p = 0.27$) as well as a non-significant, increased rate of postoperative complications (25% versus 6.67%, $p = 0.9$). Analgesic requirement was

TABLE 3. Perioperative outcomes by surgery

	Radical Nx		Simple Nx		Partial Nx		Renal biopsies		Cryoablation	
	#/val	(%/range)	#/val	(%/range)	#/val	(%/range)	#/val	(%/range)	#/val	(%/range)
n	14		6		2		2		1	
Operative parameters										
Mean operative time (min)	127.9	(100-230)	132	(45-230)	212.5	(210-215)	79	(38-120)	108	(108-108)
Median EBL (mL)	50	(25-200)	50	(25-250)	325	(150-500)	0	(0-0)	0	(0-0)
Transfusions	1	7.14%	0	0%	0	0%	0	0%	0	0%
Median LOS (days)	2	(1-14)	1	(1-2)	2	(1-3)	1	(1-1)	1	(1-1)
Postoperative complications	2	14.29%	1	16.67%	0	0.00%	0	0.00%	0	0.00%
Conversion	No		Yes (1)		No		No		No	
Pain										
Mean morphine eq. dose (mg)	20.7	(0-81.6)	36.3	(0-78.4)	22.4	(17.6-27.2)	0.8	(0-1.6)	2.4	(2.4-2.4)
VAPS day of surgery	3.6/10	(0-8)	6.6/10	(4.3-7.9)	6.5/10	(5.5-7.3)	3.8/10	(2.5-5)	0	(0-0)
VAPS POD1	3.0/10	(0.2-5)	5.5/10	(2-7.7)	3.5/10	(2.8-4.3)	3.8/10	(2.5-5)	0	(0-0)
VAPS POD2	2.6/10	(0-4.6)	5.0/10	(4.8-5.3)	4.0/10	(4-4)	n/a	n/a	n/a	n/a
VAPS POD3	1.3/10	(0-3)	n/a	n/a	4.0/10	(4-4)	n/a	n/a	n/a	n/a

TABLE 4. Pathological Data

	no./value	(%/range)
Median tumor Clinical size (cm)	4.61	(1.5-6.7)
Median tumor Pathological size (cm)	4.99	(1.5-8.5)
Pathology		
Total lesions	17	
RCC	15	88.24%
Clear cell	6	35.29%
Papillary	5	29.41%
Chromophobe	2	11.76%
Mixed	2	11.76%
AML	1	5.88%
Oncocytoma	1	5.88%
Fuhrman grade		
1	0	0.00%
2	5	41.67%
3	4	33.33%
4	3	25.00%
Positive margins	1	5.88%

compared between radical nephrectomies, which require an enlargement of the incision site for kidney removal, and the other LESS renal surgeries, which do not require enlargement of the incision. Despite a mean incision length of 5.1 cm (range 4.5 cm-6.1 cm) versus 2.5 cm, there was no significant difference in pain as measured by both total morphine equivalents (20.7 versus 23.0, $p = 0.81$) and VAPS on POD1 (3.0 versus 4.2, $p = 0.15$).

Discussion

LESS has been pursued by many centers of laparoscopic excellence because of potential to advance the central goals of minimally invasive surgery - decrease perioperative morbidity, speed convalescence, and improve cosmesis without conceding clinical outcomes.^{11,12} There has been concern regarding technical and ergonomic challenges including instrument clashing and loss of triangulation; thus instruments and techniques have evolved significantly in the past several years leading to the current state of interest and experimentation. Nonetheless, LESS is most likely to be pursued at centers with high volume laparoscopy because of a still undefined learning curve and the persistent technical demand of these procedures.

The primary objective of the current study was to describe our initial experience with LESS renal surgery for a broad range of procedures. We include a medically

diverse patient population receiving a variety of renal procedures that is comparable in size to the largest reported series.^{7,10,13} We believe we demonstrate feasibility of these procedures as well as safety with a low rate of peri and postoperative complications. Furthermore, we report a low rate of conversion to traditional laparoscopy, and reported surgical times seem comparable to traditional laparoscopy.

Our results with LESS are comparable with the few series and comparative studies published in the literature.^{7-10,13-16} White et al reported a large series of LESS partial nephrectomies (15) with a mean EBL of 422 mL, mean operative time of 196 min, and mean LOS of 4.5 days compared to our 325 mL, 212.5 min, and 2 days, respectively.¹³ They also reported a 10% overall rate of adverse events for all LESS surgeries at a mean follow up of 9 months comparable to our postoperative complication rate of 12% at a mean follow up of 6 months. Park et al reported a large series of LESS radical nephrectomies (19) with a mean EBL of 143.2 mL, mean operative time of 190.8 min, mean LOS of 2.7 days, and complication rate of 15.8% compared to our 73.1 mL, 127.9 min, 3.4 days, and 14.29%, respectively.⁷ Tugcu et al reported a large series of LESS simple nephrectomies (14) with a mean EBL of 50.71 mL, mean operative time of 117.5 min, and LOS of 2.07 days compared to our 85 mL, 132 min, and 1.4 days, respectively.¹⁰ Interestingly, all of these data are comparable to published standard laparoscopic techniques despite an inherent selection bias for LESS cases, considering these represent the initial experience for all of these authors.

The fundamental question, however, is whether LESS provides significant benefit compared to traditional laparoscopy regarding postoperative pain, convalescence time, and cosmesis. Published data for these endpoints are limited and at times conflicting.^{7-10,14} Park et al reported shorter hospital stay and less postoperative pain measured by VAPS on POD 1, 2, and 3 in LESS radical nephrectomy.⁷ In a similar analysis, Raman et al compared a mix of radical and simple nephrectomies and reported less EBL in LESS nephrectomies.⁸ However, Raybourn et al found no differences in LOS, postoperative pain, or EBL between LESS and traditional laparoscopic nephrectomy.⁹ The only prospective randomized study of LESS surgery, described by Tugcu et al, compared 14 LESS and 13 traditional laparoscopic simple nephrectomies.¹⁰ They reported less postoperative pain measured by both VAPS and postoperative use of analgesics on POD 1, 2, and 3 in the LESS group. There was also a quicker return to normal activity in the LESS surgery group.

Given that "LESS" can be used to describe a wide variety of surgical approaches, it is difficult to draw

conclusions from the published literature. For example, some LESS series allow the use of a single additional needlescopic ancillary port to assist in dissection.¹⁷ Additionally, an operation where a larger incision is initially made with multiple ports placed through this single incision also qualify as LESS. Thus it is hard to draw conclusions regarding LESS without standardizing the approach and studying it prospectively.

In our study, VAPS scores were low and comparable to the existing literature for LESS. Interestingly, VAPS for patients with enlarged incisions for specimen extraction were not significantly higher compared to those who did not require specimen extraction. This could be due to the small number of patients compared or could imply that the majority of the pain is related to kidney manipulation and not related to the few additional centimeters of incision length required to extract the specimen. Length of stay was short and equivalent to the literature for these procedures as well. Cosmesis is difficult to assess and more subjective. Only anecdotal reports of improved cosmesis are found in the literature given the lack of validated methods of assessing this endpoint. It remains difficult to discern whether patients would prefer a 5 cm periumbilical extraction incision without ancillary port-sites over multiple 5 mm ports and a 5 cm lower abdominal extraction site.

Our initial experience includes patients with a range of ASA classifications. Our data revealed that patients with "severe systemic disease" (ASA3) had a higher but non-significant overall rate of complications compared with those in lower ASA classes (ASA 1-2) (37.5% versus 6.67%, $p = 0.27$). Postoperative complication rates, while higher in patients with a higher ASA, were also not significantly different compared with ASA 1-2 patients (25.0% versus 6.67%, $p = 0.9$). Studies with increased power are clearly needed for assessment of LESS in patients with higher medical acuity, but our initial data suggest that these procedures are both safe and feasible in this population.

The outstanding complication noted in our series was the dehiscence that occurred in the patient on chronic steroids on postoperative day #9. We believe that this complication was primarily related to patient factors, but underscores the possibility of wound complications in all patients and the need for meticulous wound closure. Our tendency in the earliest cases was to minimize the skin incision and maximize our fascial defect to facilitate specimen extraction. This can make fascial closure more difficult in an area of inherent weakness at the umbilicus. Additionally, given that the incision is superior to the anatomic arcuate line, its closure requires approximation of both posterior and anterior fascial layers in contrast to traditional lower extraction sites.

We report successful application of LESS to the treatment of suspected renal malignancy. Of 17 patients treated for a renal mass, 15 (88%) were malignant on pathologic analysis. While one LESS partial nephrectomy demonstrated a focal positive margin with a negative intraoperative frozen biopsy, there were no recurrences at a mean follow up of 6 months. While longer follow up is necessary for rigorous oncological assessment of LESS partial and radical nephrectomy for RCC, our initial data demonstrate feasibility, safety, and short-term efficacy of these procedures for selected lesions. Certainly for LESS partial nephrectomy, we selected exophytic tumors and elected to use a radiofrequency ablation device to avoid the pressure of ischemia time.

Limitations of this study include its retrospective analysis, small patient cohort, and the selection bias intrinsic to early non-randomized surgical experiences. Our goal, however, was to report an initial experience with a broad swath of renal LESS procedures as an evaluation of safety and feasibility, as well as to provide a benchmark for future study. A large prospective, randomized study would help clarify uncertainties regarding objective benefits compared with traditional laparoscopy.

Conclusions

LESS surgery appears to be safe and feasible as a surgical alternative in the treatment of renal pathology including renal malignancy. Perioperative and early postoperative outcomes appear comparable with other initial studies of LESS renal surgery and reported outcomes from traditional laparoscopic procedures in this select group of patients. Prospective study is needed to determine the ultimate role of LESS in the urologist's armamentarium. □

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