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Upper Tract Urological Laparoendoscopic Single-Site Surgery (LESS)

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ABSTRACT

Background and Objectives: Our objective is to report intermediate-term outcomes for patients who have undergone upper tract urologic laparoendoscopic single-site surgery (LESS) at a single institution.

Methods: From January 1, 2008, through November 30, 2012, 107 cases treated with LESS were identified, including pyeloplasty (n = 30), ureterolithotomy (n = 32), nephrectomy (n = 35; simple = 31, partial = 4), and cyst decortication (n = 10). Perioperative data were reviewed, and conversion and complication rates were noted.

Results: The median follow-up was 21.5 months for pyeloplasty, 20.5 for ureterolithotomy, 28.0 for simple nephrectomy, 14.0 for partial nephrectomy, and 19.0 for cyst decortication. Major complications were encountered in 8 patients, including 3 intraoperative complications (2 bowel injury with serosal tearing and 1 intraoperative bleeding), which were recognized and repaired with LESS or conversion to conventional laparoscopy (CL). During the intermediate postoperative period (30–90 days) major complications occurred in 5 patients: 4 ureteral strictures (Clavien-Dindo grade [CG] IIIb) and 1 urinoma formation (CG IIIa). During the early postoperative period (<30 days), the most common minor complications were flank pain (CG I) in 16 patients and urinary tract infection (CG II) in 11, followed by urinary leakage (CG I) in 8.

Conclusions: Intermediate-term functional outcomes of this single-center study confirm that upper tract LESS is a challenging procedure that can be safe and effective when performed by an experienced team. Prospective studies with longer follow-up periods are needed to investigate the safety of LESS in the treatment of various upper urinary tract conditions.

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INTRODUCTION

Evidence supporting laparoendoscopic single site surgery (LESS) in a wide variety of procedures has been limited to small case series or retrospective case control studies with limited follow-up.[1–3] A worldwide multi-institutional case series comprising data from more than 1000 patients was lacking in follow-up information on symptom improvement, radiographic resolution, and the need for additional procedures.[4]

We have reported comparative studies of select LESS procedures (ureterolithotomy, pyeloplasty, and simple nephrectomy) in urology.[5–7] Having gained further experience over the years, we herein report cumulative intermediate-term results of 107 patients who underwent extirpative, ablative, and reconstructive upper urinary tract LESS.

METHODS

Between January 1, 2008, and November 30, 2012, 107 patients underwent LESS by a single surgeon (VT). Demographic and clinical information about the cases were prospectively entered in an institutional review board–approved database. The procedures included pyeloplasty (n = 30), ureterolithotomy (n = 32), nephrectomy (n = 35; simple, 31; partial, 4) and cyst decortication (n = 10). Specific consent for a LESS procedure was obtained from all patients, according to their operative indications.

All procedures were performed with a single-access multichannel laparoscopic port (SILS port; Covidien, Norwalk, Connecticut) and various combinations of standard and specialized bent or articulating laparoscopic instruments. Port placement was transperitoneal through the umbilicus or retroperitoneal (ureterolithotomy) at the tip of the 12th rib, based on the patient's pathology and surgeon's preference. Inclusion criteria for all patients were body mass index (BMI) less than 30 kg/m^2 and no prior abdominal

Table 1.
Patient Demographics

Procedure	Age[a]	Gender (M/F)	BMI (kg/m^2)[a]	Side (L/R)	CCI (0–5)[a]
Pyeloplasty (n = 30)	23.87 ± 10.25, 23 (8–54)	17/13	23.63 ± 2.2, 23.5 (19–29)	17/13	0.06 ± 0.36, 0 (0–2)
Ureterolithotomy (n = 32)	38.63 ± 14.37, 39 (16–75)	21/11	24.81 ± 2, 24 (21–28)	20/12	0.87 ± 1.15, 0.5 (0–5)
Cyst decortication (n = 10)	39.6 ± 2.95, 39 (35–46)	3/7	26.7 ± 1.49, 27 (24–29)	8/2	0.6 ± 0.51, 1 (0–1)
Simple nephrectomy (n = 31)	39.87 ± 7.91, 39 (24–58)	15/16	27.03 ± 1.35, 27 (24–29)	20/11	1.03 ± 0.91, 1 (0–3)
Partial nephrectomy (n = 4)	41.5 ± 12.79, 40 (28–58)	4/0	26 ± 1.41, 25.5 (25–28)	2/2	0
All patients (n = 107)	35.05 ± 12.72, 38 (8–75)	60/47	25.35 ± 2.28, 26 (19–29)	59/48	0.63 ± 0.92, 0 (0–5)

CCI, Charlson comorbidity index.

[a]Data are expressed as the mean ± SD, median (range).

surgery. Patients with a history of renal surgery or a solitary renal unit were excluded from single-port surgery.

Data on the following parameters were included in the analysis: age, gender, left or right location of the surgically treated kidney, BMI, preoperative characteristics, and comorbidities (smoking, diabetes, renal insufficiency, and hypertension), pre- and postoperative renal function, American Society of Anesthesiologists (ASA) score, Charlson Comorbidity Index (CCI), and indication for LESS. Additional collected data included intraoperative variables (e.g., additional ports, operative time, estimated blood loss, conversion, and transfusion) and postoperative and convalescence variables (e.g., hospital stay, visual analog pain scale [VAPS] scores, and time to return to work). Procedures were scored according to a scale adapted from the European Scoring System for laparoscopic urological surgery (1, slightly difficult; 6, extremely difficult).[8] Conversion from LESS to laparoscopic surgery was defined as unplanned installation of more than 1 trocar to complete the procedure. Conversion to open surgery was defined as the necessity for an unplanned abdominal incision to complete the operation.

Both medical and surgical complications occurring at any time after surgery were recorded. They were classified as intraoperative, early (onset, <30 days), intermediate (onset, 31–90 days), or late (onset, >90 days) postoperative complications. For late complications, those related to or possibly related to LESS were recorded, regardless of the time of onset. All complications were recorded, with a grade assigned according to the modified Clavien-Dindo classification system.[9] The length of follow-up was calculated as time from the date of surgery to the most recent documented examination.

Cosmetic outcomes were evaluated by using questionnaires inquiring about wound pain (0, not painful; 10, very painful), satisfaction (0, not satisfied; 10, very satisfied), and cosmesis (0, very unsightly; 10, very satisfactory) on the basis of a visual analog scale.

RESULTS

A total of 107 patients underwent LESS during the study period. The study cohort was young, nonobese, and healthy (low CCI) (**Table 1**).

All procedures were performed in the upper urinary tract; 45 (42%) were extirpative or ablative and 62 (58%) were reconstructive. Retroperitoneal access was preferentially adopted in ureterolithotomy procedures which accounted for 29.9% of the total procedures.

Mean operative time was 200, 77, 81, 109, and 201 minutes, and estimated blood loss was 55, 55, 66, 74, and 185 mL for pyeloplasty, ureterolithotomy, cyst decortication, simple nephrectomy, and partial nephrectomy (PN), respectively. PN had the highest complexity score, 1.75 ± 0.95. No additional 2-mm port was required in any LESS pyeloplasty procedure. Of the 107 LESS procedures, 6 (5.6%) (pyeloplasty, 2; ureterolithotomy, 2; simple nephrectomy , 1; and PN, 1) required conversion to conventional laparoscopy (CL) to safely complete the pro-

Table 2.
Operative Data

Procedure	OR Time (min)	EBL (mL)	CS (1–5)	Additonal Ports (n)		
				2 mm	5–12 mm	Conversion
Pyeloplasty (n = 30)	200.5 ± 45.98, 180 (150–320)	54.67 ± 31.26, 50 (20–170)	1.36 ± 0.61, 1 (1–3)	0	2	0
Ureterolithotomy (n = 32)	76.88 ± 33.64, 61 (50–175)	55.31 ± 13.62, 55 (30–80)	1.12 ± 0.42, 1 (1–3)	0	2	0
Cyst decortication (n = 10)	80.5 ± 8.31, 80 (70–90)	66 ± 21.19, 75 (40–90)	1, 1 (1–1)	0	0	0
Simple nephrectomy (n = 31)	109.2 ± 17.23, 110 (80–150)	74.03 ± 21.92, 80 (40–120)	1.51 ± 0.76, 1 (1–3)	2	1	0
Partial nephrectomy (n = 4)	201.3 ± 20.97, 197.5 (180–230)	185 ± 176.7, 97.5 (95–450)	1.75 ± 0.95, 1.5 (1–3)	1	1	0
All procedures (n = 107)	125.9 ± 61.67, 115 (50–320)	66.4 ± 44.76, 60 (20–450)	1.31 ± 0.62, 1 (1–3)	3	6	0

OR, operating room; EBL, estimated blood loss; CS, complexity score.
[a]Data are expressed as the mean ± SD, median (range).

Table 3.
Postoperative and Convalescence Data

Procedure	LOS[a]	VAPS at Discharge[a] (1–10)	Return to Work[a] (days)
Pyeloplasty (n = 30)	2.46 ± 1.3, 2.5 (1–6)	1.86 ± 0.34, 2 (1–2)	8.03 ± 0.76, 8 (7–9)
Ureterolithotomy (n = 32)	3.06 ± 1.75, 3 (2–11)	1.06 ± 0.24, 1 (1–2)	6.65 ± 3.5, 6 (4–20)
Cyst decortication (n = 10)	1, 1 (1–1)	1.2 ± 0.42, 1 (1–2)	75 ± 0.84, 7 (7–9)
Simple nephrectomy (n = 31)	2.06 ± 1.18, 2 (1–5)	1.48 ± 0.72, 1 (1–3)	10.39 ± 2.04, 10 (8–16)
Partial nephrectomy (n = 4)	4.75 ± 2.87, 3.5 (3–9)	1.25 ± 0.5, 1 (1–2)	11.5 ± 1.91, 11 (10–14)
All procedures (n = 107)	2.47 ± 1.59, 2 (1–11)	1.43 ± 0.56, 1 (1–3)	8.38 ± 2.76, 8 (4–20)

LOS, length of stay.
[a]Data are expressed as the mean ± SD, median (range).

cedure. From 2 to 5 additional ports (5–12 mm) were added during conversion, to facilitate reconstruction and control bleeding. Conversion to open surgery was not necessary in any of the patients to complete the procedure (**Table 2**).

The mean length of hospital stay was 2.47 ± 1.59 days, VAPS (visual analog pain scale) at discharge was 1.43 ± 0.56, and time to return to work was 8.38 ± 2.76 days for all patients (**Table 3**).

Complications of 107 LESS procedures according to the Clavien-Dindo classification and the actions taken for management are listed in **Table 4**.

Pyeloplasty

Of the 30 LESS-P procedures, 2 required addition of 5- to 12-mm ports to facilitate ureteropelvic anastomosis. At a median follow-up of 24.3 months (range, 13–50), 24 patients were asymptomatic, 5 had persistent flank pain (Clavien grade [CG] I) that was significantly improved, and 1 reported persistent symptoms after ureteral stent removal. The latter patient was readmitted for retroperitoneal urinoma and treated with ureteral stent placement and percutaneous urinoma drainage (CG IIIa). Of the 30 patients, 2 had urinary leakage (CG I) that required prolonged drainage, 3 had a urinary tract infection (UTI), and

Table 4.
Clavien-Dindo Classification of Complications[a]

Complication	Patients (n)	Action
Clavien I		
Ileus	4	Observation
Flank pain	16	Analgesics
Wound dehiscence	4	Observation
Urinary leakage	8	Prolonged drainage
Clavien II		
UTI	11	Antibiotics
Acute gastritis	4	PPI
Postoperative anemia	1	Transfusion
Wound Infection	1	Antibiotics
Clavien IIIa		
Urinoma formation	1	Ureteral stent placement/percutaneous urinoma drainage
Clavien IIIb		
Ureteral stricture	4	Ureteral dilatation+ureteral stent placement with subsequent resolution
Clavien IV		
Intraoperative bleeding	1	Conversion to conventional laparoscopy to control bleeding
Bowel Injury (serosal tearing)	2	Seomuscular suturing
Conversion to open surgery	—	
Major complications	8/107 (4.6%)	
Minor complications	48/107 (44.8%)	

PPI, proton pump inhibitor.
[a]Some patients had multiple complications (eg, conversion to open surgery and transfusion).

1 had a wound infection (CG II) that required antibiotics in the postoperative period. A diuretic radionuclide scan was performed in all patients at the 3-month follow-up and semiannually thereafter. Patients were examined clinically every 3 to 6 months depending on the presence of symptoms. All had a postoperative renal scan showing normal emptying time (T½) and stable renal function compared to the preoperative evaluation.

Ureterolithotomy

Retroperitoneal ureterolithotomy (LESS-RU) was performed for impacted stones (mean stone size, 19.13 ± 3.46 mm; median 18 mm; range, 15–24 mm) in the middle or upper part of the ureter. Conversion to CL was necessary in 2 patients. At a median follow-up of 20.5 months (range, 10–72), ureteral stricture (CG IIIb) developed in 4 patients after surgery and was managed by ureteral balloon dilatation and ureteral stent placement. Intravenous urography (IVU) controls performed at the 3-month follow-up detected no ureteral strictures in any of the patients. Of the 32 patients, 7 had urinary leakage (CG I) that required prolonged drainage, 5 had a UTI (CG II) that required antibiotics, and 7 had flank pain that required analgesics in the postoperative period. During the follow-up, 2 patients continued to pass calculi and were later readmitted with recurrent UTI and treated with antibiotherapy.

Cyst Decortication

Cyst decortication was performed on symptomatic patients with obstructed systems and recurrent UTI. At a median follow-up of 22 months, all patients were asymptomatic, with unobstructed drainage. Of the 10 patients, 1 had a minor serosal bowel injury sutured via the single port. This patient was observed for postoperative abdominal discomfort and bowel dysfunction, and no interven-

Table 5.
Cosmesis Outcomes and Efficacy

Procedure	Cosmetic Subjective Scar Satisfaction[a]			Follow-up Time (months)	Efficacy
	Pain	Satisfaction	Cosmesis		
Pyeloplasty (n = 30)	0.83 ± 0.64, 1 (0–2)	8.6 ± 0.62, 9 (8–10)	8.86 ± 0.57, 9 (8–10)	24.33 ± 11.45, 21.5 (13–50)	All patients symptom free
Ureterolithotomy (n = 32)	1.15 ± 0.36, 1 (1–2)	8.68 ± 0.59, 9 (8–10)	8.81 ± 0.64, 9 (8–10)	26.31 ± 17.54, 20.5 (10–72)	Technically feasible; mean stone size, 19.13 ± 3.46 mm
Cyst decortication (n = 10)	0.3 ± 0.48, 0 (0–1)	9.2 ± 0.91, 9.5 (8–10)	9 ±1.05, 9 (8–10)	22 ± 5.81, 19 (16–34)	Asymptomatic with unobstructed drainage
Simple nephrectomy (n = 31)	0.38 ± 0.61, 0 (0–2)	9.25 ± 0.81, 9 (8–10)	9.32 ± 0.74, 9 (8–10)	31.35 ± 14.42, 28 (14–60)	Morcellation and extraction in all cases
Partial Nephrectomy (n = 4)	1.25 ± 0.5, 1 (1–2)	9± 0.81, 9 (8–10)	9 ± 0.81, 9 (8–10)	14.5 ± 1.0, 14 (14–16)	Margins negative in all cases
All patients (n = 107)	0.76 ± 0.63, 1 (0–2)	8.88 ± 0.75, 9 (8–10)	9 ± 0.72, 9 (8–10)	26.37 ± 14.25, 23 (10–72)	

[a]Data are expressed as the mean ± SD, median (range).

tion was necessary. In addition, 2 other patients had wound dehiscence (CG I) requiring observation, and 2 had acute gastritis (CG II) that was relieved with postoperative medical treatment.

Simple Nephrectomy

Nephrectomy was performed in all cases for benign kidney disease, with findings consistent with chronic pyelonephritis and interstitial fibrosis and no evidence of renal cancer. Specimens were morcellated and extracted through the umbilical incision in all cases. The median period of follow-up was 28 months (range, 14–60). Of the 31 patients, 1 had bowel injury (serosal tearing) during surgical manipulation of adhesions. The intestinal serosal tear was sutured via the addition of two 10-mm ports (conversion to laparoscopy). Two patients had prolonged ileus, but recovered without intervention and were discharged according to schedule. Two patients had wound dehiscence that did not require primary closure, 1 had postoperative bleeding (CG II) that required transfusion, 2 had acute gastritis relieved by medication (PPIs), 1 had a UTI that required antibiotics, and 1 had flank pain that required analgesics during the postoperative period. At the 1-month follow-up, all patients were symptom free.

Partial Nephrectomy

PN was offered to individuals with a favorable body habitus, lower BMI, and anterior exophytic masses (<3 cm) that would not require hilar occlusion (unclamped technique). The median period of follow-up was 14 months (range, 14–16). Of the 4 patients, 1 had intraoperative bleeding that required conversion to laparoscopy (2 additional 12-mm ports) to facilitate the control of bleeding and transfusion. This patient had prolonged ileus but the condition was relieved during observation after surgery. Two of the 4 patients had flank pain that necessitated administration of postoperative analgesics. The margins were negative in all cases, and the final pathologic diagnoses were all renal cell cancer. During follow-up 14 months after surgery, there were no delayed bleeding– or PN-related complications.

Cosmetic Outcomes

Mean pain, satisfaction, and cosmesis scores for all 107 procedures performed are summarized in **Table 5**.

DISCUSSION

Minimally invasive surgery is associated with lower pain levels and shorter convalescence time compared to open surgery. Patients in need of laparoscopic upper tract intervention for nonfunctioning kidney, ureteropelvic junction obstruction, simple cyst, or ureteral stone or for oncological purposes may benefit from the advantages provided by LESS, including minimal abdominal wall trauma, decreased postoperative pain, shorter convalescence time, decreased skin incisions, and improved patient satisfaction with cosmesis. The most important bar-

rier to adaptation of LESS is the inherent ergonomic challenges, most common among which are crossing or collision of instruments, lack of triangulation, and limited in-line vision. These difficulties can be more pronounced in LESS-PN, LESS-P, and retroperitoneoscopic ureterolithotomy (LESS-RU) which require precise dissection and intracorporeal suturing and reconstruction. In the current study, we reviewed our cumulative experience with LESS upper urinary tract surgery at a single institution, and analyzed the intermediate-term results.

Until recently, only 3 large series of urologic LESS had been reported. In 2009, White et al[1] described a single-institution experience with the first 100 LESS urologic procedures. Conversion to CL was necessary in 6 patients, and no case in their series was converted to open surgery. The reported overall complication rate was 11%.

A 2-center experience with a total of 100 LESS procedures was reported by Desai et al.[2] The addition of one or more ports was necessary in 6 cases, and conversion to open surgery was necessary in 4. The overall conversion rate was 10%, with 1 death after a simple prostatectomy. The overall complication rate was 14%.

Choi et al[3] reported a cumulative experience with 171 patients treated with LESS. Seven (4.1%) patients were reported to have intraoperative and 9 (5.3%) to have postoperative complications. Seven surgeries (4.1%) were converted to mini-incision open procedures.

We sought to perform the entirety of the procedure through a single incision. When additional trocars were needed, they were added in a stepwise fashion, beginning with a single trocar outside of the incision and progressing to CL. Six cases were ultimately converted to laparoscopy as a result of failure of progression (pyeloplasty, 2; ureterolithotomy, 2; simple nephrectomy, 1; and partial nephrectomy, 1). In 2 cases, the additional 2-mm trocar was planned and subsequently used for the control of bleeding in simple nephrectomy. No procedure required conversion to open surgery. Irwin et al[10] reported conversion to CL and complication rates in LESS during upper tract urologic procedures on 125 patients. Conversion to CL was necessary in 5.6%, and complications occurred in 15.2% of the cases of LESS surgery. Kaouk et al[4] reported an overall conversion rate of 20.8% (15.8% in reduced-port laparoscopy, 4% in CL or robot-assisted surgery, and 1% in open surgery). The intraoperative complication rate in this series was 3.3%. Most complications were managed with conservative measures, with conversion to open or laparoscopic surgery occurring in only 0.7% of cases. Postoperative complications, mostly low grade, were reported in 9.5% of cases.

In our study, all procedures were performed in an acceptable length of time, and we were cognizant of procedure progression, with a low threshold for adding trocars or converting as needed. The estimated blood loss (EBL) was limited; only a single patient required a blood transfusion (CG II). Major complications were encountered in 8 patients, including 3 intraoperative complications (2 bowel injury with serosal tearing, 1 intraoperative bleeding), which were recognized and repaired by with the LESS approach or by conversion to CL. During the early postoperative period (<30 days), the most common minor complication was flank pain (CG I) in 16 patients and UTI (CG II) in 11, followed by urinary leakage (CG I) in 8. During the intermediate postoperative period (30–90 days) major complications occurred in 5 patients with 4 ureteral strictures (CG IIIb) and 1 urinoma formation (CG IIIa).

Functional outcomes have been encouraging for LESS-RU, with a median 20.5 months of follow-up. A major complication of LESS ureterolithotomy is ureteral stricture, which may develop from tight sutures that cause ischemia followed by ureteral stenosis.[11] Mitchinson and Bird[12] have reported that prolonged postoperative urinary drainage with retroperitoneal fibrosis is another possible cause of ureteral stenosis. IVU controls at the 3-month follow-up showed no ureteral strictures in any of our patients. Our results are comparable with the findings reported in previous case series. Of note, Nouira et al[11] have analyzed several reports and estimated the average rate of ureteral stricture after LESS-RU or CL-RU to be 2.5%.

Our median follow-up of 24.33 months for pyeloplasty was significantly longer than those reported by different groups in the literature.[13] Our mean operative time, median LOS, and mean time to return to work were all within the ranges of reported values for LESS pyeloplasty procedures. In our series, 100% (30/30) of patients reported their symptoms to be completely resolved or improved after the procedure, and no patient needed repeat pyeloplasty or endopyelotomy. In a meta-analysis of studies comparing conventional laparoscopic and robotic pyeloplasty, Best et al[14] reviewed their initial series of LESS pyeloplasty, focusing on the 30-day complication rate. Complications were reported in 7 (25%) patients, 71% of which occurred in the initial 10 patients. The authors concluded that LESS pyeloplasty is a technically challeng-

ing procedure, even for an experienced laparoscopic surgeon.

PN represents a challenging procedure in the best of conditions. Initially, Kaouk and Goel[15] performed unclamped resection in all patients. Further, they chose low-to-interpolar masses, to avoid the need for a liver retractor. Based on their early experience, they proposed that small, exophytic, anterior, interpolar-to-lower-pole renal masses were the ideal lesions for the LESS and R-LESS approaches. A recent review of the articles on LESS showed that it has been performed exclusively by very skilled laparoscopic surgeons. The authors noted that the majority of the 110 cases (62 robot-assisted) described in the literature were very small masses with a diameter less than 3 cm (mean operating time, 179 minutes; mean EBL, 249 mL). Eighteen percent of the cases were performed without ischemia; in the others, the mean warm ischemia time (WIT) was 21 minutes (transfusion rate, 7.5%). Severe complications were infrequent (5.4%) and, in a high percentage of the cases, additional trocars were added.[16] More recently, a large multicenter analysis reported that low Padua score tumors are the best candidates for LESS-PN and that the application of a robotic platform is likely to reduce the overall risk of postoperative complications.[17] Despite gaining experience with several LESS applications, we believe that this approach is still technically more challenging than CL when performing PN.

In our study group, patients were relatively young and nonobese and had low surgical risk, with no history of abdominal surgery. The patient selection for LESS was more rigorous than that for other minimally invasive techniques. Our study merits several considerations and qualifications. First, this report represents cumulative observational outcomes only and should not be considered as a report on the superiority of LESS over standard laparoscopy.

Although several published reports have described shorter recovery, less pain, and cosmetic benefit with the single-port approach, these preliminary outcomes should be supported with further studies.[6,14] Multicenter, randomized, controlled trials are necessary to answer these questions. Second, we have not yet quantified or compared cosmetic satisfaction with a validated questionnaire.

Finally, one might argue that any novel surgical technique must be compared with the standard technique before any conclusions can be drawn concerning its benefits. Assembling a control group for the analysis was outside the scope of the study. The benefits of LESS surgery compared with standard laparoscopy remain to be documented, and reports of long-term outcomes are also needed, to demonstrate the functional equivalence of LESS procedures versus open or standard laparoscopic surgery.

Analysis of intermediate-term functional outcomes from the present single-center study confirmed that upper tract LESS represents a challenging procedure that can be safely and effectively performed in experienced hands. More prospective studies with long-term follow-up are needed to investigate the safety of the LESS technique in the treatment of various upper urinary tract procedures.

CONCLUSION

LESS is a feasible method, enabling shortened convalescence time and offering high levels of patient satisfaction, and it can be applied to the gamut of urologic indications. In accordance with major reported laparoscopic series, our findings show that urologic LESS can be performed with a low complication rate in experienced hands. The low conversion rates suggest that early adopters of the technique have adhered to the principles of careful patient selection and safety in this early phase of LESS application. Continued innovation including a purpose-built robotic operating platform may allow faster incorporation of single-port surgery into standard practice.

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