Laparoendoscopic Single-site Surgery: Initial Hundred Patients

Mihir M. Desai, Andre K. Berger, Ricardo Brandina, Monish Aron, Brian H. Irwin, David Canes, Mahesh R. Desai, Pradeep P. Rao, Rene Sotelo, Robert Stein, and Inderbir S. Gill

OBJECTIVES To report our initial experience with laparoendoscopic single-site (LESS) surgery in 100 patients in urology.

METHODS Between October 2007 and December 2008, we performed LESS urologic procedures in 100 patients for various indications. These included nephrectomy (N = 34; simple 14, radical 3, donor 17), nephroureterectomy (N = 2), partial nephrectomy (N = 6), pyeloplasty (N = 17), transvesical simple prostatectomy (N = 32), and others (N = 9). Data were prospectively collected in a database approved by the Institutional Review Board. All procedures were performed using a novel single-port device (r-Port) and a varying combination of standard and specialized bent/articulating laparoscopic instruments. Robotic assistance was used to perform LESS pyeloplasty (N = 2) and simple prostatectomy (N = 1). In addition to standard perioperative data, we obtained data on postdischarge analgesia requirements, time to complete convalescence, and time to return to work.

RESULTS In the study period, LESS procedures accounted for 15% of all laparoscopic cases by the authors for similar indications. Conversion to standard multiport laparoscopy was necessary in 3 cases, addition of a single 5-mm port was necessary in 3 cases, and conversion to open surgery was necessary in 4 cases. On death occurred following simple prostatectomy in a Jehovah's Witness due to patient refusal to accept transfusion following hemorrhage. Intra- and postoperative complications occurred in 5 and 9 cases, respectively. Mean operative time was 145, 230, 236, and 113 minutes and hospital stay was 2, 2.9, 2, and 3 days for simple nephrectomy, donor nephrectomy, pyeloplasty, and simple prostatectomy, respectively.

CONCLUSIONS The LESS surgery is technically feasible for a variety of ablative and reconstructive applications in urology. With proper patient selection, conversion and complications rates are low. Improvement in instrumentation and technology is likely to expand the role of LESS in minimally invasive urology. UROLOGY 74: 805–813, 2009. © 2009 Elsevier Inc.

Laparoscopic surgery is beginning to gain acceptance as a standard of care in many intra-abdominal procedures in urology. With increasing experience in the laparoscopic environment, efforts are now directed at further minimizing morbidity and improving cosmetic outcomes. This has led to the development of techniques, multichannel single-access ports, and novel bent/articulating instruments that could allow the laparoscopic procedure to be performed through a single skin incision often hidden within the umbilicus.[1-4] Although several variants of this approach have been reported in the published data on surgery under various terminologies and acronyms, a recently convened international multidisciplinary consortium of experts have coined the term LESS (LaparoEndoscopic Single Site) surgery to collectively encompass laparoscopic procedures performed through a single skin incision (Gill et al, unpublished data).

We have previously reported the initial developmental experiences with select LESS procedures in urology.[3,4,5-7] After considerably increasing our experience over the past year, we herein report cumulative data in the initial 100 patients undergoing ablative and reconstructive LESS surgery with a view to presenting a more mature perspective on the emerging field of single-access urologic surgery.

MATERIAL AND METHODS

Between October 2007 and December 2008, we performed LESS urologic procedures in 100 patients. These procedures

From the Department of Urology, Glickman Urological and Kidney Institute, Cleveland Clinic, Cleveland, Ohio; Muljibhai Patel Urological Hospital Gujarat, India; and Clinica la Floresta, Caracas, Venezuela

Reprint requests: Mihir M. Desai, M.D., Stevan B. Streem Center for Endourology and Glickman Urological and Kidney Institute, Cleveland Clinic, 9500 Euclid Ave, A100, Cleveland, OH 44195. E-mail: desaim1@ccf.org

Submitted: January 2, 2009, accepted (with revisions): February 4, 2009

0090-4295/09/$34.00
doi:10.1016/j.urology.2009.02.083

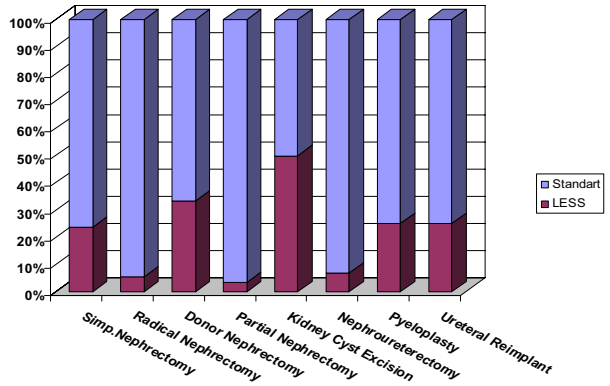

Figure 1. Graph shows the percentage of LESS cases performed using vis-à-vis standard laparoscopy by the same surgeon in the same duration.

comprised 15% of the total number of laparoscopic procedures (N = 67; excluding 33 transvesical LESS procedures) performed by the authors in the same duration for similar indications (Fig. 1). Data were prospectively entered in an Institutional Review Board approved database and were retrospectively reviewed. The various LESS procedures performed included nephrectomy (N = 34; simple 14, radical 3, donor 17), nephroureterectomy (N = 2), partial nephrectomy (N = 6), pyeloplasty (N = 17), simple prostatectomy (N = 32), and others (N = 9). The detailed list of procedures and indications are outlined in Table 1.

All procedures were performed using a novel single-port device (r-Port, Advanced Surgical Concepts, Wicklow, Ireland) for access. Access was obtained through the umbilicus in all 67 laparoscopic cases and through a solitary incision in the suprapubic crease in the 33 transvesical cases. The detailed description and functioning of the r-Port has been described previously. Our technique for LESS nephrectomy, pyeloplasty and reconstructive procedures, donor nephrectomy, partial nephrectomy, and simple prostatectomy are detailed elsewhere. In general, we used standard laparoscopic instrumentation for most dissection and retraction maneuvers. Pre-bent instruments and specialized articulating instruments such as LaparoAngle (Cambridge Endo, Framington, MA) and RealHand (Novare Surgical Systems, Cupertino, CA) were selectively used. We used, via a skin puncture, an ancillary 2-mm Verres needle-port with needlescopic graspers to assist during suturing for all reconstructive and select ablative procedures (to facilitate retraction). A rigid 5 mm, 30°, or a flexible-tip 0° digital video-laparoscope (EndoEYE, Olympus Medical, Japan) was used in all 100 cases. Three LESS procedures (1 transvesical simple prostatectomy and 2 pyeloplasty) were performed using robotic assistance (da Vinci S, Intuitive Surgical, Sunnyvale, CA). The robotic transvesical simple prostatectomy was performed using the 4-channel r-Port through which the robotic camera and working trocars were inserted. For robotic LESS pyeloplasty, the robotic telescope and 15-mm working instrument were inserted through the 3-channel r-Port, and the other working instrument was passed through a robotic trocar inserted through a separate fascial puncture alongside the r-Port but through the same umbilical incision. All maneuvers in the 3 robotic LESS cases were performed robotically by the surgeon at the console.

All data were analyzed and reported as mean ± SD, median (range). Analgesia scores, narcotic requirements, convalescence data, and time off work were reported for procedures involving more than 10 cases.

RESULTS

Demographic data are detailed in Table 2. For the entire cohort, the mean age was 47 ± 21 (10-89) years, mean BMI was 26 ± 5 (15-41), and 15% patients had undergone abdominal surgery previously. Mean operative time was 145, 230, 236, and 113 minutes, and estimated blood loss was 109, 104, 79, and 423 mL for simple nephrectomy, donor nephrectomy, pyeloplasty, and simple prostatectomy, respectively (Table 2). Mean hospital stay was 2, 2.9, 2, and 3 days; time to return to work was 19, 17, 22, and 14 days; and time to complete convalescence was 32, 25, 31, and 15 days for simple nephrectomy, donor nephrectomy, pyeloplasty, and simple prostatectomy, respectively (Table 3).

An additional 5-mm port was required in 3 cases and 3 cases were converted to standard multiport laparoscopy (Table 4). Two patients undergoing transvesical prostatectomy required extension of the suprapubic incision to facilitate digital enucleation of the adenoma to complete the procedure. Two additional patients in the transvesical prostatectomy group required open conversion for managing an inadvertent bowel injury and bleeding, respectively (vide infra). One death occurred in a Jehovah's Witness undergoing simple prostatectomy due to refusal to accept blood transfusion for hemorrhage due to coagulopathy. In this patient, the intraoperative blood loss was 50 mL and good hemostasis was secured on enucleation of adenoma; subsequently, persistent oozing was noted, and blood transfusions and clotting factors were refused by the patient. All maneuvers including open surgical suturing, packing of the prostatic fossa and bilateral internal artery embolization failed to stop the bleeding. Intraoperative complications were noted in 5 patients (bleeding 4, bowel injury 1) and postoperative complications in 9 cases (bleeding 4, corneal abrasion 1, drug-induced dyskinesia 1, urinary tract infection 1, urine leak 1).

Most complications (3 intraoperative and 5 postoperative) were seen with the single-port transvesical enucleation of the prostate (STEP) procedure. There was an inadvertent bowel injury in a patient with previous laparotomy, which occurred during intravesical insertion of the r-Port. The injury was recognized at the completion of the procedure and was repaired by laparotomy without further sequelae. One patient undergoing the STEP procedure had intraoperative bleeding requiring transfusion that was managed by placing sutures. Bleeding in the immediate postoperative was seen in 4 patients undergoing STEP procedure; 1 patient required open surgical exploration for securing hemostasis and 3 patients were managed conservatively with blood transfusion.

Injury to the renal and gonadal vein occurred in 1 patient each undergoing LESS adrenalectomy and radical nephrectomy, respectively. There was minor oozing due to partial avulsion of the gonadal vein close to its origin

Table 1. LESS procedures (N = 100): indications and patient demographics

LESS Procedure	No. Patients	Indication	Age (y) Mean ± SD Median (Range)	BMI Mean ± SD Median (Range)
Simle nephrectomy	14	Benign nonfunctioning kidney	34 + 1728 (16-78)	24 ± 4 23.5 (17.5-27)
Radical nephrectomy	3	Kidney tumor	68 + 1664 (54-86)	30.5 30 (30-31)
Donor nephrectomy	17*	Renal donation	39 ± 13 42 (21-65)	26 ± 4 25 (20-32)
Partial nephrectomy	6	Kidney tumor	60 ± 16 62 (34-80)	26 ± 4 25 (22-32)
Kidney cyst excision	1	Extrinsic compression and ureteropelvic junction obstruction	58	32
Nephroureterectomy	2	Upper tract TCC (n = 1) severe reflux + recurrent pyelonephritis (n = 1)	13/55	18/27
Pyeloplasty	17†	Primary ureteropelvic junction obstruction	39 ± 23 29 (10-79)	22 ± 6 23 (15-35)
Ureteral reimplant	2	Ureteral stricture	42, 22	25, 20
Ileal ureter	3	Ureteral stricture	49 ± 25 51 (23-72)	26 ± 2 25.2 (24-28.4)
Simple prostatectomy	32‡	BPH (> 80 g)	70 ± 8 71 (57-89)	26 ± 4 26 (19-41)
Transvesical mesh sling removal	1	Erosion of sling into bladder with stone formation	71	34
Adrenalectomy	1	Adrenal mass	50	26
Hysterectomy	1	Fibroids and menorrhagia	50	29
Total	100		47 ± 21 44 (10-89)	25.5 ± 5 25 (15-41)

* One patient undergoing LESS donor nephrectomy underwent concomitant adrenalectomy.
† Two LESS pyeloplasties were performed using robotic assistance.
‡ One patient undergoing simple prostatectomy was performed using robotic assistance.

from the inferior vena cava that was adequately controlled with clips. The renal vein injury during LESS adrenalectomy was successfully suture-repaired after conversion to standard laparoscopy. The patient with renal vein injury was subsequently found to have a renal vein thrombus necessitating chronic anticoagulation. The renal vein is patent at 3-month follow-up. Addition of an extra 5-mm port was necessary in 3 cases for liver retraction (N = 2), or tissue retraction (N = 1). Apart from the 2 vascular complications, conversion to laparoscopy was necessary in a patient undergoing pyeloplasty for secondary ureteropelvic junction obstruction, who had significant peri-ureteropelvic junction adhesions and who ultimately required a nephrectomy, as it was a long-segment stricture and a borderline functioning kidney.

Treatment efficacies for various LESS procedures were comparable to standard laparoscopic results reported in published studies and are detailed in Table 4. All patients undergoing radical nephrectomy had negative surgical margins. Median warm ischemia time for the donor nephrectomy group was 5.8 (2.5-10) minutes. One allograft (warm ischemia time 3.8 minutes, completely uneventful intraoperatively) was lost on postoperative day 1 from intrarenal vascular thrombosis of unclear etiology. All patients in the pyeloplasty group remain symptom-free. Postoperative imaging showed unobstructed drainage in 15 of the 16 patients in whom data was available. The patients undergoing ileal interposition (N = 3) and ureteroneocystostomy (N = 2) show unobstructed drainage at latest follow-up. Apart from the patient who died, the remaining 31 patients undergoing transvesical simple prostatectomy show improvement in flow rates and symptom scores and no patient has urinary incontinence. The patient undergoing excision of the calcified mesh developed recurrent stone formation at the previous site and is scheduled to undergo a transvesical partial cystectomy with suture reconstruction.

COMMENT

The last decade has witnessed an exponential increase in laparoscopic and robotic surgery for the treatment of various surgical disorders. Within urology, a significant number of reconstructive and ablative procedures for benign and oncologic indications are being performed using laparoscopic/robotic techniques with comparable efficacy and reduced morbidity vis-a-vis their open surgical counterpart. Efforts are ongoing to further decrease morbidity and visible scarring of laparoscopic surgery. Natural orifice translumenal endoscopic surgery (NOTES) is

Table 2. LESS urologic procedures (N = 100): operative data

Procedure	OR Time (min) Mean ± SD Median (Range)	EBL (mL) Mean ± SD Median (Range)	Complications		Additional Ports		Conversion
			Intra	Post	2 mm	5 mm	
Simple nephrectomy	145 ± 69 200 (70-300)	109 ± 81 100 (20-300)	0	0	5 (41%)	0	0
Radical nephrectomy	208 ± 44 208 (177-208)	200 ± 141 200 (100-300)	1	0	3 (100%)	0	0
Donor nephrectomy	230 ± 50 220 (180-320)	104 ± 66 50 (50-200)	0	2	17 (100%)	0	0
Partial nephrectomy	271 ± 39 270 (240-336)	475 ± 327 525 (11-1000)	0	1	6 (100%)	0	1 lap*
Kidney cyst excision	60	< 50	0	0	1 (100%)	0	0
Nephroureterectomy	90/200	75/300	0	0	0	1	0
Pyeloplasty	236 ± 84 225 (120-360)	79 ± 41 62 (10-150)	0	0	19 (100%)	2	1 lap*
Ureteral reimplant	210, 140	100, 250	0	0	2 (100%)	0	0
Ileal ureter	330 ± 42 330 (300-360)	170 ± 113 170 (90-250)	0	0	3 (100%)	0	0
Simple prostatectomy	113 ± 71 90 (45-360)	423 ± 564 250 (50-2500)	3	5	0	0	2 open† 2 open‡
Transvesical mesh removal	100	10	0	1	0	0	0
Adrenalectomy	150	650	1	0	1 (100%)	0	1 Lap§
Hysterectomy	120	350	0	0	0	0	0
Total	—	—	**5**	**9**	**57**	**3**	**7**

Additional 5-mm ports were required in 3 cases: Liver retraction (N = 2), tissue retraction (N = 1).
* difficult mobilization of the ureter.
† 1 enterotomy, 1 bleeding.
‡ failure to progress.
§ bleeding.

Table 3. Less urologic procedures (N = 100) postoperative and convalescence data

Procedure	Hospital Stay Mean ± SD Median (Range)	×Morphine Equivalents (mg)	×Post-Discharge Analgesic Use (d)	×Return to Work (d) Mean ± SD Median (Range)	×Complete Convalescence (d) Mean ± SD Median (Range)
Simple nephrectomy	2 ± 1 2 (1-4)	64 ± 46 76 (0-104)	13 ± 11.2 28 (1-10)	19 ± 9.4 23 (6-28)	32 ± 6 28 (28-40)
Radical nephrectomy	3.5 ± 2 3.5 (2-5)	—	—	26.5	51
Donor nephrectomy	2.9 ± 1 3 (1-6)	23 ± 27 7 (0-57)	3.7 ± 3.7 3 (0-10)	17 ± 7 10 (10-31)	25 ± 13 21 (14-42)
Partial nephrectomy	7.2 ± 8 4 (2-22)	28 ± 22.5 28 (5-50)	4.7 ± 4 7 (0-7)	24.5 ± 15 24.5 (14-35)	21 ± 12 14 (14-35)
Kidney cyst excision	1	—	—	—	—
Nephroureterectomy	5/1	—	—	—	—
Pyeloplasty	2 ± 0.5 2 (2-3)	28 ± 26 29.7 (0-63)	2.6 ± 4 1 (0-10)	22 ± 018 18 (7-45)	31 ± 17 28 (14-60)
Ileal ureter	2	—	—	—	—
Re-implant	4	—	—	—	—
Simple prostatectomy	3 ± 2 2 (1-10)	29 ± 37 21 (0-95)	1.6 ± 1 1 (1-4)	14 ± 9 10 (7-30)	15 ± 6 14 (10-30)
Transvesical mesh removal	1	—	—	—	—
Adrenalectomy	3	—	—	—	—
Hysterectomy	2	—	—	—	—

In-house and postoperative analgesia requirements, convalescence and return to work data are only being reported for procedures with more than 5 cases.

an approach that aims at using a natural orifice to perform intra-abdominal procedures, using a combination of laparoscopic and endoscopic techniques. Despite significant interest in NOTES, its application is currently limited to the laboratory. This is primarily due to the lack of versatility and robustness of currently available instrumentation and the concern about the safety and reliability of visceral closure. As a consequence of these limitations, almost all clinical NOTES procedures performed till date has used transabdominal assistance. The LESS

Table 4. LESS urologic procedures (N = 100): complications and efficacy

Procedure	Complications	Efficacy
Simple nephrectomy	None	• Technically, feasible in all cases • All cases morcellated and extracted
Radical nephrectomy	• Gonadal vein avulsion in 1 patient that was clipped	• 1 transvaginal extraction • Final pathology: all RCC, margins negative
Donor nephrectomy	• Corneal abrasion • Dyskinesia from antiemetics	• Median warm ischemia: 5.8 min • Extraction: umbilicus • One graft loss due to intravascular clotting on pod # 1
Partial nephrectomy	• Bleeding needing angioembolization	• Final pathology: RCC 4 patients, AML 1, oncocytoma1 • Margins negative in all cases • Median warm ischemia:
Kidney cyst excision	None	• Asymptomatic with unobstructed drainage
Nephroureterectomy	None	• Distal ureter management: cystoscopic resection + laparoscopic EndoGIA • Final pathology: T1, Low grade
Pyeloplasty	None	• All patients symptoms free • Success rate: 15/16 (93.5%; image FU available for 16/19 patients)
Ureteral reimplant	None	• Both patients show unobstructed drainage on follow-up imaging
Ileal ureter	• One patient had anastomotic leak requiring nephrostomy drainage	• All 3 patients show unobstructed drainage • Bowel anastomosis performed extracorporeally through the r-Port by disconnecting the valve
Simple prostatectomy	• Mortality in a Jehovah's witness from hemorrhage • Bleeding requiring suturing (n = 1) • Bowel injury requiring exploration • Postoperative bleeding requiring exploration (n = 1) • Postoperative bleeding requiring transfusion (n = 4) • Postoperative UTI (n = 1)	• Preoperative TRUS prostate size: 98 g • Weight of the enucleated adenoma: 59 g • 31 patients show unobstructed voiding with improvement in IPSS and peak flow rate.
Transvesical mesh removal	None	• Recurrent stone formation
Adrenalectomy	• Right renal vein injury suture repaired after conversion to multiport laparoscopy. The patient developed renal vein thrombus requiring chronic anticoagulation. • Renal vein patent at 3 month follow-up.	• Final pathology: hemorrhagic cyst
Hysterectomy	None	• Final pathology: myomas

IPSS = International Prostate Symptom Score.

surgery is an alternative approach to NOTES that shares the same "scarless" philosophy is to perform laparoscopic surgery through a single skin incision, typically concealed within the umbilicus. The LESS procedure may use purpose-specific single-access ports that allow simultaneous passage of multiple laparoscopic instruments or use of separate standard low-profile trocars inserted through a single skin incision. A variety of terminologies have been used to describe these single-incision procedures. Recently, a consensus meeting supported the term LESS surgery to encompass the spectrum of laparoscopic procedures performed through a single skin incision (Gill et al, unpublished data). Although anecdotal reports of LESS surgery have appeared mainly in the published studies on general surgery and gynecology over the last several years, refinement of access ports, optics, and instrument technology has contributed to the recent surge in interest.[1-4] This technological advance has primarily revolved around development of single-port devices such as the r-Port (Advanced Surgical Concepts), UniX System (pNavel Inc.), and articulating instruments such as LaparoAngle (Cambridge Endo, Framington, MA), RealHand (Novare Surgical Systems, Cupertino, CA), and EndoRoticulate (Covidien, Norwalk, CT). The availability of small video-laparoscopes (EndoEYE, Olympus Medical, Japan) with a low external profile and in-line optics and light cables has also facilitated the development of LESS procedures.

Since the initial report of LESS nephrectomy by Raman et al[1] (transumbilical, multiple ports) and Rane et al[2] (single-port device, extraumbilical incision), several investigators have demonstrated the technical feasibility

of a variety of urologic procedures. These include advanced reconstructive procedures such as pyeloplasty, ileal interposition, ureteroneocystostomy,[5] and technically challenging procedures such as partial nephrectomy,[6] radical prostatectomy,[7] and donor nephrectomy.[8]

Our report details the initial series of 100 consecutive LESS urologic procedures for various indications with very strict patient selection. In the present experience, LESS accounted for only 15% of all laparoscopic upper tract procedures performed at our institute, in the same duration for similar indications. In our opinion, LESS seems ideally suited for upper tract reconstructive procedures such as pyeloplasty and benign ablative indications such as simple nephrectomy. Laparoscopic pyeloplasty is often indicated in the younger patient population in which a good cosmetic result may be an important consideration. Treatment efficacy, in this early experience and relatively short follow-up seems to approach that of standard laparoscopic pyeloplasty. We were also able to deal with factors such as crossing vessels and concomitant renal stones during LESS pyeloplasty. Simple nephrectomy for benign disease is similarly a suitable indication for LESS as these nonfunctioning kidneys are routinely morcellated, thus restricting the skin incision to within the umbilicus, which confers an excellent cosmetic result (Fig. 2).

Despite the obvious technical challenges involved in the procurement of a renal allograft in a safe and functionally optimal fashion, the obvious cosmetic advantage and potentially reduced morbidity with LESS surgery may be particularly attractive for the otherwise healthy kidney donor. After developing the technique of LESS donor nephrectomy in 4 patients, we have now expanded our experience to 17 patients. One graft was lost from intravascular clotting on postoperative day 1 after an uncomplicated LESS donor nephrectomy with a warm ischemia time of 3.8 minutes. In the entire LESS donor nephrectomy cohort, our median warm ischemia time was 5.8 minutes, and median total operative time was 240 minutes. On comparing LESS and standard laparoscopic donor nephrectomy, the LESS cohort had a longer median warm ischemia time (3 vs 6 minutes, $P = .001$), a similar hospital stay (3 days each) but decreased analgesic requirements (80 vs 125 mg MSO_4; $P = .27$), earlier return to work (17 vs 51 days; $P = .001$) and quicker convalescence (25 vs 97 days; $P = .03$) (Canes et al, unpublished data) Short-term allograft function following LESS and standard laparoscopic donor nephrectomy was comparable at 1 month (serum creatinine 1.4 vs 1.2 mg/dL; $P = .4$).

Although our current experience includes select patients with cancer (N = 10), LESS should be used even more selectively in this patient population. This is illustrated as that although our current experience report includes LESS partial nephrectomy (N = 6) and LESS radical nephrectomy (N = 3), they accounted for 3.3% and 5.5% of the overall laparoscopic partial nephrectomy and laparoscopic radical nephrectomy experience, respectively (Fig. 1). This is in contrast to simple nephrectomy, donor nephrectomy, and pyeloplasty in which LESS procedures accounted for 24%, 33%, and 25% of the procedures, respectively. We have recently published our initial experience with LESS partial nephrectomy in 5 patients with a renal tumor. Median operative time was 270 minutes, estimated blood loss was 150 mL, and warm ischemia time was 20 minutes. One patient had a postoperative bleed requiring angioembolization and all patients had negative surgical margins. The LESS partial nephrectomy at the current time should be reserved for the highly select patient with favorable tumor anatomy and performed by an experienced laparoscopic team. In the current era of nephron-sparing surgery, radical nephrectomy is generally reserved for

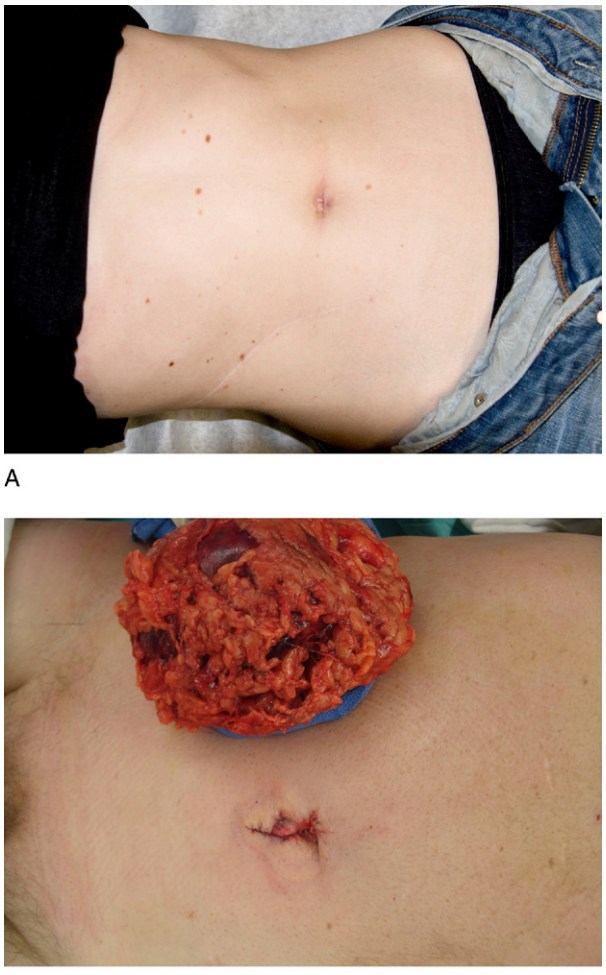

Figure 2. (A) External picture of the hardly visible umbilical scar in a patient undergoing LESS simple nephrectomy. The entire procedure including extraction of the morcellated kidney was performed through a 2-cm incision completely concealed within the umbilicus. The contralateral flank scar in the same patient is from a previous spine surgery. **(B)** External picture of an intact extracted kidney and reconstructed umbilical incision in a patient undergoing LESS radical nephrectomy for a 6-cm central renal tumor.

larger, more complex tumors that generally require a larger extraction incision. Therefore, with the exception of women in whom the en bloc intact specimen can be extracted vaginally, radical nephrectomy may not be as attractive an option for LESS surgery when compared to other upper tract procedures.

A novel development made possible by LESS is the ability to perform advanced intraluminal surgical manipulations within a hollow organ, a concept hitherto not feasible. Placement of multiple ports into a hollow organ (bladder, stomach) to perform intraluminal surgery is technically cumbersome. In comparison, intraluminal entry, and secure exit, of a single port into a hollow organ appears more feasible and reliable. The unique design of the r-Port allows direct percutaneous insertion of the access port into the bladder, providing an air-tight seal for establishing pneumovesicum. We reported a novel technique of STEP for large-volume BPH.[9] We have now performed the STEP procedure in 32 patients till date, and these data will be reported in a separate communication. We believe this new capability to obtain a reliable airtight single-portal multichannel access into the lumen of a hollow viscus can potentially be extended to select other surgical applications.[10]

In the ultimate analysis, for LESS surgery to be more widely adopted, it has to demonstrate patient benefits beyond merely the cosmetic ones. Only 2 initial reports are available on comparison of LESS with standard laparoscopy that show conflicting trends. Early data in a limited number of patients show evidence of decreased morbidity from LESS compared to standard laparoscopic donor nephrectomy. In contrast, Raman et al[11] failed to demonstrate any difference in short-term outcomes of convalescence comparing 11 LESS to 22 standard laparoscopic nephrectomies. Specifically, the authors showed no difference in length of stay, in-house analgesia requirement, or complication rates between the 2 groups. However, the study did not report any data on complete convalescence or return to work. Both studies were retrospective reviews, with only a limited number of patients. We believe that an adequately powered prospective randomized comparison between LESS and standard laparoscopy using tools designed to detect subtle differences in morbidity and assess cosmetic satisfaction will ultimately determine the future of LESS surgery. In this regard, creation of prospective multicenter, procedure-specific registries for various LESS procedures has been identified as a top-priority at the LESS Consortium meeting.

Despite gaining experience with several LESS applications, we believe that this approach remains more technically challenging compared with conventional laparoscopy. Although we have successfully performed LESS surgery with a relatively low complication and conversion rate, it is far from being a routine standard of care. In fact, in the present study, LESS accounted for only 15% of overall laparoscopic cases. As such, given that the current benefits of LESS are largely cosmetic, we recommend a very low threshold for conversion to standard laparoscopy. Robotic assistance with the da Vinci Surgical System has been used to perform LESS procedures.[12] We used robotic assistance to perform simple prostatectomy and pyeloplasty. In our opinion, significant instrument clashing and robotic arms are limitations of incorporating the current da Vinci system to routinely perform the LESS procedure. Ongoing refinement of technology, particularly the development of novel platforms specific for LESS surgery, is critical to promote its routine widespread use. In this regard, technologies such as the magnetic anchoring and guidance system (MAGS)[13] and flexible[14] and in-vivo robotics[15] are attractive technologies on the horizon that may help circumvent some of the limitations of current LESS surgery that stem from instrument crowding and relative lack of triangulation.

CONCLUSIONS

The LESS urologic surgery is feasible for select indications, albeit technically challenging. With proper patient selection, complication and conversion rates are low. Outcomes in the short term appear comparable to conventional laparoscopy as reported in published data. Prospective studies comparing outcomes of LESS surgery with standard laparoscopy will determine the future direction of this approach.

References

1. Raman JD, Bensalah K, Bagrodia A, et al. Laboratory and clinical development of single keyhole umbilical nephrectomy. *Urology*. 2007;70:1039-1042.
2. Rane A, Rao P, Rao P. Laparoscopic-singleport-access nephrectomy and other urologic procedures using a novel single port device (r-port). *Urology*. 2008;72:260-263.
3. Desai MM, Rao PP, Aron M, et al. Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report. *BJU Int*. 2008;101:83-88.
4. Kaouk JH, Haber GP, Goel RK, et al. Single-port laparoscopic surgery in urology: initial experience. *Urology*. 2008;71:3-6.
5. Desai MM, Rao PP, Stein R, et al. Embryonic natural orifice Transumbilical endoscopic Surgery (E-NOTES) for advanced reconstruction: initial experience. *Urology*. 2009;73:183-187.
6. Aron M, Canes D, Desai MM, et al. Transumbilical single-port laparoscopic partial nephrectomy. *BJU Int*. 2009;103:516-521.
7. Kaouk JH, Goel RK, Haber GP, et al. Single-port laparoscopic radical prostatectomy. *Urology*. 2008;72:1190-1193.
8. Gill IS, Canes D, Aron M, et al. Single port transumbilical (E-NOTES) donor nephrectomy. *J Urol*. 2008;180:637-641.
9. Desai MM, Aron M, Canes D, et al. Single-port transvesical simple prostatectomy: initial clinical report. *Urology*. 2008;72:960-965.
10. Desai MM, Aron M, Berger A, et al. Transvesical robotic radical prostatectomy. *BJU Int*. 2008;102:1666-1669.
11. Raman JD, Bagrodia A, Cadeddu JA. Single-incision, umbilical laparoscopic versus conventional laparoscopic nephrectomy: a comparison of perioperative outcomes and short-term measures of convalescence. *Eur Urol*. 2008 (in press).
12. Kaouk JH, Goel RK, Haber GP, et al. Robotic single-port transumbilical surgery in humans: initial report. *BJU Int*. 2009;103:366-369.

13. Zeltser IS, Bergs R, Fernandez R, et al. Single trocar laparoscopic nephrectomy using magnetic anchoring and guidance system in the porcine model. *J Urol.* 2007;178:288-291.
14. Desai MM, Aron M, Gill IS, et al. Flexible robotic retrograde renoscopy: description of novel robotic device and preliminary laboratory experience. *Urology.* 2008;72:42-46.
15. Rentschler ME, Oleynikov D. Recent *in vivo* surgical robot and mechanism developments. *Surg Endosc.* 2007;21:1477-1481.

EDITORIAL COMMENT

We congratulate the authors for amassing the largest urologic experience with LESS procedures. They certainly demonstrate that this new laparoscopic technique is feasible and applicable to a variety of urologic pathologies. However, trying to interpret the results in this compilation of 13 different LESS surgeries is difficult—the tables provided can serve as initial benchmarks for perioperative outcomes. Focusing on the higher volume procedures reported, the LESS transvesical simple prostatectomy appears to be a challenging case requiring further refinement as complications occurred in 25% of cases (most being major complications). Moreover, for LESS nephrectomy (simple or donor), it is feasible and safe, though in my opinion the advantage will remain mainly cosmetic. As such, the authors are correct in that LESS surgery should be employed selectively and comprise a small percentage of a laparoscopic urology practice. In fact, I do not believe that a yet to be determined small advantage in convalescence or cosmesis will justify routine LESS partial nephrectomy and LESS simple or radical prostatectomy.

Nevertheless, the urologic community cannot overlook LESS surgery as there is a strong industry and clinical (general surgery) support for developing these procedures. It is only a matter of time before the urologic patient will develop interest in these procedures as well. Having demonstrated feasibility, we now need to investigate outcomes compared to conventional laparoscopy[1,2] to define the appropriate role of LESS surgery.

Jeffrey A. Cadeddu, M.D., Department of Urology, UT Southwestern Medical Center, Dallas, Texas

References

1. Zeltser IS, Bergs R, Fernandez R, et al. Single trocar laparoscopic nephrectomy using magnetic anchoring and guidance system in the porcine model. *J Urol.* 2007;178:288-291.
2. Desai MM, Aron M, Gill IS, et al. Flexible robotic retrograde renoscopy: description of novel robotic device and preliminary laboratory experience. *Urology.* 2008;72:42-46.

doi:10.1016/j.urology.2009.04.027
UROLOGY 74: 812, 2009.

EDITORIAL COMMENT

We applaud the authors for their work in assessing the applicability of laparoendoscopic single-site surgery (LESS). This approach is a more practical alternative to pure natural orifice transluminal endoscopic surgery (NOTES). Several previous studies have demonstrated the feasibility of LESS in urology, for both extirpative and reconstructive surgeries.[1,2] The current series reviews to a considerable extent the safety and reproducibility of this technique. It should be pointed out, however, that in a significant proportion of these cases, the surgery described was not true "single-site surgery." The authors note that all reconstructive cases (including partial nephrectomy, pyeloplasty, etc.) involved the use of an additional 2-mm trocar with accompanying instruments to complete these procedures. The use of an additional trocar, regardless of size, was needed to overcome the hurdles of retraction, triangulation, and instrument clashing. The morbidity and cosmetic effect of the additional small incision can be debated, and may be trivial, but in our view is not necessary even for reconstructive LESS procedures.[3]

Is LESS a temporary "stepping stone" on the path to a truly scarless intervention, or is it a meaningful and lasting technique? Is it chicanery or progress? Because the internal procedure is the same as standard laparoscopy, removing and minimizing trocar sites may not have a huge effect on recovery. Indeed, previous needlescopic approaches that promised similar advantages did not progress in clinical practice.[4] In a large part, this was because of the high level of technical expertise necessary to offer this approach. Developments in instrumentation will simplify LESS and lead to wider diffusion, or a quantum leap forward in another direction will render LESS obsolete.

Regardless of the role of LESS in the surgical armamentarium of the future, we embrace and validate the underlying principle that is driving this development. The modern surgeon must strive to address improved cosmesis, postoperative pain, hospital stay, and recovery time while achieving to cure patients.

Lee Richstone, M.D., and Louis Kavoussi, M.D., Smith Institute for Urology, Hofstra School of Medicine, The North Shore-Long Island Jewish Health System, Long Island, NY

References

1. Desai MM, Rao PP, Aron M, et al. Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report. *BJU Int.* 2008; 101:83-88.
2. Raman JD, Bagrodia A, Cadeddu JA. Single-incision, umbilical laparoscopic versus conventional laparoscopic nephrectomy: a comparison of perioperative outcomes and Short-Term measures of convalescence. *Eur Urol.* 2008;55:1198-1206.
3. Rais-Bahrami S, Montag S, Atalla M, et al. Laparoendoscopic single-site Surgery (LESS) of the kidney with no accessory trocars: an initial experience. *J Endourol.* 2009;23:1319-1324.
4. Gill IS, Soble JJ, Sung GT, et al. Needlescopic adrenalectomy—the initial series: comparison with conventional laparoscopic adrenalectomy. *Urology.* 1998;52:180-186.

doi:10.1016/j.urology.2009.04.029
UROLOGY 74: 812, 2009.

REPLY

We thank Richstone and Kavoussi for their sage comments. Clearly, the use of an adjunctive 2-mm needle-port is not always necessary, nor do we use it as such. However, in reconstructive cases, it offers a ready, morbidity-free solution to allow