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Laparo-Endoscopic Single Site (LESS) versus Standard Laparoscopic Left Donor Nephrectomy: Matched-pair Comparison

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Abstract

Background: Laparo-Endoscopic Single Site (LESS) surgery is a recent development in minimally invasive surgery. Presented herein is the initial comparison of LESS donor nephrectomy (LESS-DN) and standard laparoscopic living donor nephrectomy (LLDN).
Objective: To determine whether LESS-DN provides any measurable benefit over LLDN during the perioperative period and subsequent convalescence.
Design, setting, and participants: Between November 2007 and November 2008, 18 consecutive patients underwent LESS-DN (17 left DN, 1 right DN). A contemporary matched-pair cohort of 17 patients undergoing standard LLDN was selected for retrospective comparison.
Interventions: LESS-DN was performed through an intraumbilical novel multichannel port. The kidney was extracted through a slightly extended umbilical incision.
Measurements: All data were prospectively accrued in an institutional review board–approved database. Convalescence data included visual analog pain scores and questionnaires containing patient-reported time to recovery end points.
Results and limitations: One right-sided donor was converted to standard laparoscopy and excluded from analysis. Baseline demographics, operating time, blood loss, and hospital stay were comparable between groups. Compared to LLDN, patients undergoing LESS-DN had similar in-hospital analgesic requirements and mean visual analog scores at discharge. After discharge, patient-reported convalescence was faster in the LESS-DN group, including days on oral pain medication (20 vs 6; $p = 0.01$), days off work (46 vs 18; $p = 0.0009$), and days to 100% physical recovery (83 vs 29; $p = 0.03$). Mean warm ischemia time was longer in the LESS-DN group (3 vs 6.1 min; $p < 0.0001$); however, allograft function was immediate and comparable between groups. One allograft in the LESS-DN group thrombosed postoperatively. Regardless of laparoscopic approach, patients' global satisfaction with kidney donation and willingness to recommend their procedure to others were favorable and equivalent between groups.
Conclusions: This retrospective matched-pair comparison between LESS-DN and LLDN suggests that the single-port approach may be associated with quicker convalescence. In this initial series, LESS-DN had longer ischemia time, yet early allograft outcomes were comparable.

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1. Introduction

Since its first description in 1995 [1], laparoscopic living donor nephrectomy (LLDN) has become the technique of choice at many, if not most, major academic centers. Although complication rates were initially higher than open surgery [2], subsequent mature reports indicate equivalent complication rates and graft outcomes to open donor nephrectomy (DN) [3,4].

Standard upper-tract laparoscopy requires 3–6 small incisions whereby proper tissue triangulation and stable retraction can be reliably achieved. With the advent of novel multichannel single ports as well as curved and articulating instruments, the possibility of complex laparoscopy through a single incision has been reported both from our and other centers [5–7]. When the umbilicus is used as the access point, the postoperative scar is largely concealed within the navel. The term *laparoendoscopic single-site* (LESS) surgery was recently coined as an appropriate acronym by consensus [8].

The benefits of shorter hospital stay, rapid convalescence, and improved cosmesis following LLDN may have increased donor willingness, thereby decreasing barriers to donation [9,10]. Nevertheless, donor kidneys remain in short supply. In an attempt to further decrease morbidity, we recently presented the initial report of LESS-DN [11]. In these first four cases, DN was successfully completed without intraoperative complications, and each allograft functioned immediately.

Before gaining wider acceptance, LESS-DN must be compared to standard LLDN in a prospective, randomized, and ultimately multicenter fashion. While in the preparation phases of embarking on such a study, we sought to evaluate in a more immediate fashion whether LESS-DN provides any measurable benefit beyond superior cosmesis.

In this paper, we report the first retrospective matched-pair comparison of LESS to standard LLDN. For comparison, 17 contemporary patients undergoing standard LLDN were selected and matched for age, sex, body mass index (BMI), side of nephrectomy, surgical history, number of arteries/veins/ureters, kidney volume, and surgical date (±6 mo).

2. Materials and methods

Between November 2007 and November 2008, 18 consecutive patients underwent LESS-DN. All potential donors were evaluated by a multidisciplinary transplant team and met usual criteria for donation. All LESS procedures were performed through an intraumbilical single-access multichannel laparoscopic port, the R-Port (Advanced Surgical Concepts, Dublin, Ireland), by two surgeons (ISG, MMD). Through a 2-mm Veres needle port inserted via direct skin puncture in the hypochondrium, a 2-mm needlescopic grasper was inserted selectively to aid in tissue retraction and dissection in all cases. All data were prospectively accrued in an institutional review board (IRB)–approved database. LESS-DN was performed with IRB approval and waiver. Intravenous morphine, fentanyl, and dilaudid as well as oral pain medication administered from the recovery room to the moment of discharge were converted to equianalgesic morphine equivalents. Follow-up information was obtained from office visits and a scripted telephone questionnaire (Appendix A), administered by physician members of the research team with whom patients were personally unfamiliar. Convalescence was measured by visual analog pain scores and patient-reported time to end points.

We have previously described the components, working mechanism, and application of the multilumen R-Port [6] as well as adjunctive use of 2-mm needlescopic instruments [12]. Our technique of standard LLDN has also been described elsewhere [13]. Briefly, standard left LLDN requires two 12-mm trocars (right hand, camera port) and one 5-mm trocar (left hand). For lateral retraction, either an additional 5-mm trocar or a 2-mm needlescopic grasper is used. The kidney is retrieved using a 6–7-cm low Pfannenstiel extraction incision.

2.1. Laparoendoscopic single-site left donor nephrectomy

With the patient in a 45° flank position (Fig. 1), pneumoperitoneum is established either using a transumbilical open Hasson technique or via Veres needle puncture in the left hypochondrium. A 2–2.5-cm vertical intraumbilical skin incision is made. The tethered umbilical skin folds

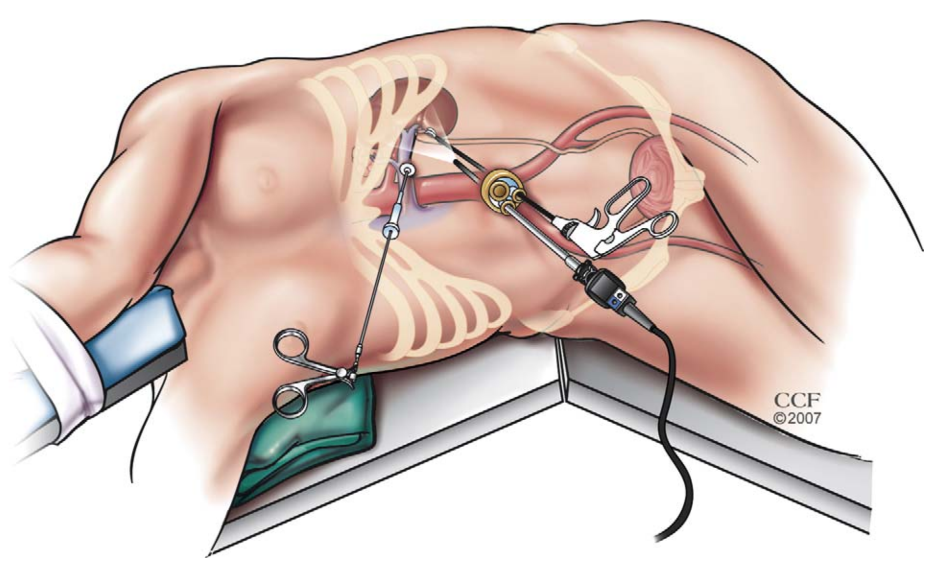

Fig. 1 – Schematic representation of intraumbilical R-Port 2-mm needlescopic grasper for laparoendoscopic single-site left donor nephrectomy.

are sharply released from the rectus fascia in the midline. A 2–3-cm vertical midline anterior rectus fasciotomy is made, the abdominal cavity is entered, and a sweep of the finger verifies lack of underlying adhesions. The R-Port is deployed and secured in place. A 5-mm 30° rigid laparoscope with integrated camera head (EndoEYE, Olympus, Orangeburg, NY, USA) is used for visualization. Standard laparoscopic instruments are used for the majority of the procedure. Specialized instruments, including curved (Novare Surgical Systems, Cupertino, CA, USA) or articulating (Cambridge Endo, Framingham, MA, USA) instruments are used as necessary.

Intra-abdominally, the LESS-DN surgical technique duplicates standard LLDN. As such, the descending colon, spleen, and tail of the pancreas are mobilized generously, such that they retract medially without the need for constant retraction. If the mesentery is bulky, the camera assistant uses a 5-mm bowel grasper through one of the 5-mm inlets of the R-Port for active medial retraction.

At the level of the lower pole of the kidney, the ureter and gonadal vein packet are elevated off the psoas muscle. The gonadal vein is maintained intact and traced cephalad to the renal vein. Stay sutures of 2-0 Vicryl affixing the Gerota fascia to the abdominal side wall can be utilized for secure lateral retraction. The renal vein is skeletonized, the adrenal vein is divided between titanium clips, and the adrenal gland is released from the upper pole. Akin to standard LLDN, the renal vein is dissected completely up to the interaortocaval region, and the renal artery is dissected to its aortic origin, taking care not to induce arterial spasm. Lateral kidney attachments are left untouched until the hilar dissection is complete.

The ureter is divided at the pelvic inlet after confirming adequate diuresis (generous volume resuscitation, mannitol, Lasix administration). The kidney is circumferentially mobilized, with its perirenal fat intact. A 15-mm Endocatch bag is detached from its introducer. A stiff guidewire is introduced through the drawstring seam to give the mouth of the Endocatch bag some memory in an open configuration. The bag is tightly rolled and introduced through the 12-mm inlet of the R-Port, with the ends of the guidewire and the drawstring externalized through the gel elastomer valve. The kidney is pre-entrapped, with the mouth of the bag positioned around the intact hilum, and the guidewire is withdrawn. The bag is loosely cinched around the hilum.

The artery is divided after placing two Hem-o-lock clips (Teleflex Medical, Research Triangle Park, NC, USA) and one metal clip on the stay side. The renal vein is divided at the interaortocaval region with a 12-mm vascular ENDO GIA stapler (Covidien, Dublin, Ireland). The R-Port is removed, and the rectus fasciotomy is extended beneath the skin cranially and caudally (Fig. 2). The umbilical skin incision is extended to approximately 4 cm. The prebagged specimen is gently extracted and placed on ice. Warm ischemia time is defined from renal artery occlusion to back-table perfusion with ice-cold modified Euro-Collins solution. The rectus fascia is partially closed, the R-Port replaced, and the surgical bed inspected for hemostasis. Laparoscopic exit proceeds in the usual manner. For both standard and LESS-DN, all skin incisions were infiltrated with local anesthesia at the conclusion of the case.

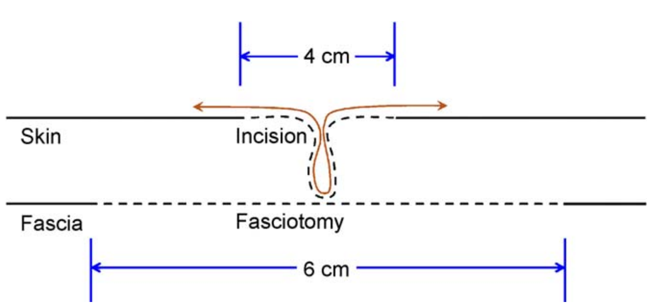

Fig. 2 – Line drawing to conceptualize specimen extraction. Midline fasciotomy (approximately 6–7 cm) extends cranial and caudal to the limit of the skin incision (approximately 4 cm) to widely accommodate the prebagged allograft. The umbilical fold stretches to allow atraumatic extraction of the now longitudinally oriented allograft.

Statistical analysis was performed using the JMP v.7 software (SAS Institute Inc, Cary, NC, USA). Data are reported as mean plus or minus standard deviation (SD), median, and range. Continuous data were compared using the Wilcoxon rank sum test. Nominal data were compared using the Pearson χ^2 test. A p value < 0.05 was considered significant.

3. Results

LESS-DN was completed successfully in 17 patients. Demographic data are presented in Table 1. No procedure was converted to open surgery. One right-sided LESS-DN was converted to LLDN by placing additional 5-mm trocars to retract the bulky liver; this patient was therefore excluded from the LESS-DN group. All 17 remaining LESS-DN allografts were left-sided. Matched-pair groups were similar with regard to age, sex, BMI, kidney volume, anatomic complexity, and surgical date.

Table 2 outlines intraoperative variables. Operative time (239 vs 269 min; $p = 0.3$) and estimated blood loss (141 vs 108 ml; $p = 0.2$) did not differ between the LLDN and LESS-DN groups, respectively. Median length of the intraumbilical incision was 4.1 cm in the LESS group. Measurements of allograft renal artery, vein, and ureteral length are listed only for LESS, as they were not routinely measured in the standard LLDN group. No intraoperative complications occurred in either group. Postoperative complications occurred in two patients in the LESS-DN group; one had corneal abrasion and the other had allograft thrombosis. The latter patient underwent a completely uncomplicated LESS-DN with 3.8 min of warm ischemia time and initially decreasing recipient serum creatinine. On routine postoperative day 1 Doppler, no flow was seen, and the patient was reexplored. This scan revealed patent anastomoses and a few viable glomeruli on renal biopsy. Subsequent follow-up renal scans demonstrated no flow, and biopsy revealed cortical necrosis. The patient underwent allograft nephrectomy at 1 wk. History–pathology revealed nonviable glomeruli without evidence of rejection. This patient's postoperative serum creatinine data were excluded from analysis.

Mean warm ischemia time was longer in the LESS-DN group (3 vs 6.1 min; $p < 0.0001$). Recipient allograft function demonstrated no statistical difference between groups at up to 3 mo (Table 3). Mean recipient serum creatinine levels following LLDN and LESS-DN were 1.3 and 1.5 mg/dl ($p = 0.6$) at 1 mo and 1.3 and 1.5 mg/dl ($p = 0.2$) at 3 mo, respectively.

Hospital stay was similar between groups (3.5 vs 3 d; $p = 0.2$). In-hospital mean morphine equivalents (97 vs 100 mg; $p = 0.9$) and discharge visual analog pain scores (1.4 vs 2.7; $p = 0.2$) were also comparable. After discharge, patients undergoing LESS-DN required oral pain medication for a shorter duration (20 vs 6 d; $p = 0.01$), returned to work sooner (46 vs 18 d; $p = 0.0009$), and reported quicker "100% postoperative recovery from the physical effects of the operation" (83 vs 29 d; $p = 0.03$).

Table 1 – Demographic characteristics

	Standard LLDN	LESS-DN	*p* value
Total no.	17	17	–
Mean age, yr*	39 ± 10, 43, 23–53	38 ± 13, 40, 21–65	0.4
Male/female*	4 (23.5%)/13 (76.5%)	5 (29%)/12 (71%)	1
BMI*	26 ± 4, 25.6, 20–35	26 ± 3, 25, 20–32	0.8
Left kidney	17	17	–
Mean allograft volume on CT scan (cm^3)*	198 ± 68, 177, 103–374	183 ± 44, 169, 130–261	0.8
Anatomic complexity (more than one artery, vein, and/or ureter)	4 (25%)	5 (29%)	1

LLDN = laparoendoscopic living donor nephrectomy; LESS-DN = laparoendoscopic single-site donor nephrectomy; BMI = body mass index; CT = computed tomography; SD = standard deviation.
* Reported as mean ± SD, median, range.

Table 2 – Intraoperative results*

	Standard LLDN	LESS-DN	*p* value
Operative time, min	239 ± 54, 222, 150–331	269 ± 86, 240, 180–495	0.3
Estimated blood loss, ml	141 ± 65, 100, 50–250	108 ± 67, 50, 50–200	0.2
Warm ischemia time, min	3 ± 0.6, 3, 2–4.2	6.1 ± 2, 6, 2.8–10.3	<0.0001
Incision length, cm	N/A	4.1 ± 0.8, 4, 3–6	–
Artery length, cm		3.2 ± 0.7, 3.5, 2–4	
Vein length, cm		3.6 ± 0.9, 4, 2–5	
Ureter length, cm		14.9 ± 1.1, 15, 12–16	

LLDN = laparoendoscopic living donor nephrectomy; LESS-DN = laparoendoscopic single-site surgery-donor nephrectomy; N/A = not applicable; SD = standard deviation.
* Reported as mean ± SD, median, range.

When rating their overall kidney-donation experience, each group reported equal satisfaction scores. Using self-reported overall scar satisfaction, the LESS-DN group gave higher mean ratings to the appearances of their scars (9.7 vs 7.7; $p = 0.003$; Fig. 3). All patients studied would recommend the procedure to a friend or family member contemplating kidney donation.

4. Discussion

Donor nephrectomy, whether open or laparoscopic, holds the surgeon to the highest standard of surgical precision. Of paramount concern are the combined requirements of harvesting a quality kidney, achieving excellent transplant allograft outcomes, maintaining donor safety, and

Table 3 – Postoperative results

Donor data	Standard LLDN	LESS-DN	*p* value
Length of stay, d*	3.5 ± 1.2, 3, 2–7	3 ± 1.2, 3, 1–6	0.2
Morphine equivalents, mg*	97 ± 58, 98, 5–204	100 ± 62, 97, 2–201	0.9
Visual analog pain score at discharge*	1.4 ± 1.6, 1, 0–5	2.7 ± 2.6, 3.5, 0–8	0.2
Days on oral pain pills*	20 ± 19, 14, 2–70	6 ± 6, 4, 0–21	0.01
Days to return to work*	46 ± 21, 49, 14–90	18 ± 11, 14, 5–45	0.0009
Days to 100% physical recovery*	83 ± 80, 60, 14–300	29 ± 15, 26, 14–60	0.03
Patient-reported overall experience (1–10 scale), mean	8.5	9.5	0.053
Scores	10 (31%)	10 (58%)	–
	9 (23%)	9.5 (8.5%)	
	8 (38%)	9 (25%)	
	4 (8%)	8 (8.5%)	
Patient-reported scar satisfaction (1–10 scale), mean	7.7	9.7	0.003
Scores	10 (23%)	10 (75%)	–
	9 (23%)	9.5 (8.3%)	
	8 (8%)	9 (8.3%)	
	7 (23%)	8 (8.3%)	
	5 (15%)		
	4 (8%)		
Percentage that would recommend to a friend or family member	100%	100%	–
Allograft outcomes			
1-mo serum creatinine (mg/dl)*	1. 3 ± 0.4, 1.3, 0.8–2.4	1.5 ± 0.5, 1.3, 0.7–2.6	0.6
3-mo serum creatinine (mg/dl)*	1.3 ± 0.3, 1.3, 0.7–1.9	1.5 ± 0.3, 1.5, 0.9–1.9	0.2

LLDN = laparoendoscopic living donor nephrectomy; LESS-DN = laparoendoscopic single-site surgery-donor nephrectomy; SD = standard deviation.
* Reported as mean ± SD, median, range.

Fig. 3 – Postoperative photograph of a donor's abdomen at 1 wk.

minimizing complications. Only after satisfying these primary conditions can one move forward to consider secondary issues of cosmesis and donor morbidity. The initial transition from open to laparoscopic DN was not smooth, with increased ureteral complications noticed with LLDN in the early experience [2]. These initial hurdles have been overcome, such that LLDN is now a standard and decidedly less morbid procedure [14]. Even so, room for improvement exists. Although some suggest that the Pfannenstiel extraction incision is less morbid than an extended port site incision, it is not completely benign [15]. Patients occasionally experience local neuropathy [16]. In addition, trocar-site morbidity remains a concern for standard laparoscopy, including epigastric vessel injury, herniation, and pain. Thus, many rationales for exploring LESS exist, not the least of which is advancing the field by making standard laparoscopic surgery even less invasive. In theory, LESS-DN, apart from the requisite visceral morbidity of the nephrectomy itself, generates access trauma more or less akin to a mesh-free umbilical hernia repair.

Intraoperative outcomes were equivalent between LESS and standard LLDN in this initial experience. From a technical standpoint, intraoperative issues such as adequacy of exposure, appearance of the kidney, vessel and ureteral length, and urine output could be achieved akin to standard LLDN. Sixteen of 17 allografts functioned immediately, with no discernible difference in the quality of the harvested kidney between the LESS-DN and LLDN cohorts. In the patient with allograft thrombosis, we could not identify any clear-cut reason, despite extensive immunologic/pathologic review and consultations. Although not reaching statistical significance, mean operative time was longer in the LESS group by approximately 30 min. This is attributable to the learning curve with instrument clashing, which required continual troubleshooting between the primary and assistant surgeon, even though all LESS-DN procedures were performed by surgeons with considerable laparoscopic experience. Blood loss and hospital stay were comparable between groups. No left LESS-DN procedure was converted to standard laparoscopy.

Warm ischemia time was twice as long in the LESS-DN group. The majority of this extra time consisted of creating an adequate fascial incision, as this site cannot be prepared prior to extraction; prematurely extending the fasciotomy may evacuate pneumoperitoneum. In addition, prebagging the kidney and surrounding perinephric fat, with the renal hilum intact, can be challenging on occasion. In one patient, the densely adherent perinephron fat made prebagging the kidney impossible; as such, bagging was accomplished under warm ischemic conditions in this patient (total warm ischemia time: 10.3 min; total specimen weight: 794 g). Every attempt must be made to keep ischemia time low but not at the expense of hemostasis and donor safety. In the range of the ischemia times reported herein, available evidence suggests negligible impact on short- and long-term allograft function [13,17]. Notwithstanding, we are confident that the warm ischemia times of LESS-DN will match times for standard LLDN once the learning curve is surmounted.

Morbidity of surgery equates with more than the sum of its incision lengths and relates to a multitude of factors—operative time, delicacy of tissue handling, muscle-splitting or muscle-sparing incisions, trauma to cutaneous nerves, inherent pain thresholds, and preexisting patient expectations, to name just a few. To wit, patients undergoing open radical prostatectomy and robotic-assisted prostatectomy can be treated on the same pathway and be safely discharged on the first postoperative day [18]. Similarly, patients undergoing standard LLDN and hand-assisted LLDN have been reported to have comparable morbidity [19].

Raman et al reported a retrospective case-control comparison of LESS and standard laparoscopic nephrectomy, finding no difference using standard measures of in-hospital morbidity [20]. Similarly, in our study, in-hospital morphine equivalents, discharge visual analog pain scores, and hospital stay were not statistically different. If an immediate difference does exist, however, it would be difficult to discern using these yardsticks. As regards morphine equivalents, there is no standard postoperative order set at our institutions, with each house officer prescribing the pain medication regimen of his or her choice. At discharge, patients have differing levels of pain medication on board, potentially influencing their visual analog pain score. This was also neither standardized nor measurable, making these numbers difficult to interpret. Finally, length of stay is a soft end point in this study, because donors comprise an altruistic group that may express the desire to remain in the hospital longer because of psychosocial considerations. As such, medical readiness for discharge may not always equate with actual hospital discharge.

Given the above, we developed a specific convalescence questionnaire focused on patient-reported time to specific, easily recalled postoperative events (Appendix A). Patient-reported measures of early convalescence were significantly shorter for patients undergoing LESS-DN. Average pain medication duration was $<$1 wk, compared to almost 3 wk for conventional laparoscopy. Patients returned to work before the 3-wk mark, while those in the standard laparoscopic group returned to work almost 7 wk postoperatively. Complete resolution of physical symptoms occurred within 1 mo following LESS-DN, compared to almost 3 mo in the standard LLDN group. The ranges listed in Table 3 for these measures of convalescence are broader in the standard LLDN group. The variability in convalescence seemed less pronounced following LESS-DN, where some patients required no pain pills, returned to work 10 d later, and felt fully recovered at 2 wk. The extent to which a psychological bias is at play is difficult to determine. That is, patients in the LESS-DN group knew they had undergone a newer, less-invasive procedure and may have patterned their behavior as well as their subjective recall of their experience to match. One might similarly attribute this group's higher self-described scar rating to a type of confirmation bias, where new events are interpreted in light of preconceptions.

We acknowledge other limitations of our study. It is a retrospective study, with its inherent biases, and compares two small sample groups. Patients were subject to recall bias when recounting their convalescence variables. Questions were phrased in an identical and deliberately neutral fashion in order to prevent response bias. One would expect that patients would have been equally subject to these biases in each group and therefore would be less likely to affect our results. Our study would have been enhanced using standardized quality-of-life instruments.

This report constitutes the first clinical comparison of LESS to standard LLDN and has implications for this emerging technique for other indications. The incremental decrease in morbidity needs to be verified prospectively, across several procedures, and at multiple institutions. If these data are substantiated, we will be faced with the next crucial question: value of incremental benefit in patient morbidity versus the added intraoperative technical challenge. If we felt at any point that the patient or graft would be compromised, we planned to place additional trocars, and conversion to standard laparoscopy did occur in one case. Because LLDN requires the utmost precision, at all times patient and allograft safety concerns remain paramount.

5. Conclusions

The initial comparison of LESS-DN to a retrospectively matched-pair cohort undergoing standard LLDN is presented. Measures of in-hospital morbidity were equivalent. Warm ischemia time is prolonged, as this report includes the development curve for the LESS procedure. Allograft outcomes were comparable at 1 mo and 3 mo. Preliminary data suggest that LESS-DN shortens convalescence, as measured by pain medication requirement after discharge, time off work, and time to resolution of physical symptoms. Prospective studies are warranted.

Author contributions: Inderbir S. Gill had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Gill, Desai, Goldfarb, Shoskes.
Acquisition of data: Canes, Berger, Brandina.
Analysis and interpretation of data: Berger, Brandina, Canes.
Drafting of the manuscript: Canes, Gill, Desai.
Critical revision of the manuscript for important intellectual content: Gill, Canes, Aron, Desai.
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Appendix A. Patient questionnaire

1. How would you rate your overall experience donating your kidney on a scale of 1–10, with 10 being delighted and 1 being very displeased?
2. How many days, weeks, or months did you require oral pain pills after being discharged from the hospital?
3. How may days, weeks, or months before you went back to work after being discharged from the hospital?
4. How many days, weeks, or months before you felt 100% recovered from the physical effects of the operation?
5. How would you rate your surgical scar(s) on a scale of 1–10, with 10 being delighted and 1 being very displeased?
6. Would you recommend that a friend or family member in a similar situation undergo your procedure? Yes/No.

References

[1] Ratner LE, Ciseck LJ, Moore RG, Cigarroa FG, Kaufman HS, Kavoussi LR. Laparoscopic live donor nephrectomy. Transplantation 1995; 15:1047–9.
[2] Philosophe B, Kuo PC, Schweitzer EJ, et al. Laparoscopic versus open donor nephrectomy: comparing ureteral complications in the recipients and improving the laparoscopic technique. Transplantation 1999;68:497–502.
[3] Derweesh IH, Goldfarb DA, Abreu SC, et al. Laparoscopic live donor nephrectomy has equivalent early and late renal function outcomes compared with open donor nephrectomy. Urology 2005;65:862–6.
[4] Troppmann C, Perez RV, McBride M. Similar long-term outcomes for laparoscopic versus open live-donor nephrectomy kidney grafts: an OPTN database analysis of 5532 adult recipients. Transplantation 2008;85:916–9.
[5] Canes D, Desai MM, Aron M, et al. Transumbilical single-port surgery: evolution and current status. Eur Urol 2008;54:1020–30.
[6] Desai MM, Rao PP, Aron M, et al. Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report. BJU Int 2008;101:83–8.
[7] Raman JD, Bensalah K, Bagrodia A, Stern JM, Cadeddu JA. Laboratory and clinical development of single keyhole umbilical nephrectomy. Urology 2007;70:1039–42.

[8] Gill IS, Advincula AP, Aron M, et al. Consensus statement of the consortium for laparo-endoscopic single-site (LESS) surgery. Surg Endosc. In press.
[9] Ratner LE, Hiller J, Sroka M, et al. Laparoscopic live donor nephrectomy removes disincentives to live donation. Transplant Proc 1997;29:3402–3.
[10] Kuo PC, Johnson LB. Laparoscopic donor nephrectomy increases the supply of living donor kidneys: a center-specific microeconomic analysis. Transplantation 2000;69:2211–3.
[11] Gill IS, Canes D, Aron M, et al. Single port transumbilical (E-NOTES) donor nephrectomy. J Urol 2008;180:637–41.
[12] Soble JJ, Gill IS. Needlescopic urology: incorporating 2-mm instruments in laparoscopic surgery. Urology 1998;52:187–94.
[13] Alston C, Spaliviero M, Gill IS. Laparoscopic donor nephrectomy. Urology 2005;65:833–9.
[14] Hadjianastassiou VG, Johnson RJ, Rudge CJ, Mamode N. 2509 living donor nephrectomies, morbidity and mortality, including the UK introduction of laparoscopic donor surgery. Am J Transplant 2007;7:2532–7.
[15] Tisdale BE, Kapoor A, Hussain A, Piercey K, Whelan JP. Intact specimen extraction in laparoscopic nephrectomy procedures: Pfannenstiel versus expanded port site incisions. Urology 2007;69:241–4.
[16] Whiteside JL, Barber MD, Walters MD, Falcone T. Anatomy of ilioinguinal and iliohypogastric nerves in relation to trocar placement and low transverse incisions. Am J Obstet Gynecol 2003;189:1574–8.
[17] Simforoosh N, Basiri A, Shakhssalim N, Ziaee SA, Tabibi A, Moghaddam SM. Effect of warm ischemia on graft outcome in laparoscopic donor nephrectomy. J Endourol 2006;20:895–8.
[18] Nelson B, Kaufman M, Broughton G, et al. Comparison of length of hospital stay between radical retropubic prostatectomy and robotic assisted laparoscopic prostatectomy. J Urol 2007;177:929–31.
[19] Kocak B, Baker TB, Koffron AJ, Leventhal JR. Laparoscopic living donor nephrectomy: a single-center sequential experience comparing hand-assisted versus standard technique. Urology 2007;70:1060–3.
[20] 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 2009;55:1198–206.