

Transvaginal Route for Kidney Extraction in Laparoscopic Donor Nephrectomy

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ABSTRACT

Background and Objectives: The aim of this retrospective study was to compare conventional laparoscopic living-donor nephrectomy with transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy in terms of feasibility and reproducibility.

Methods: A total of 115 consecutive female patients who underwent laparoscopic living-donor nephrectomy (n = 70) or transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy (n = 45) were included and compared in terms of operative characteristics, as well as donor and recipient outcomes.

Results: No significant difference was observed between the laparoscopic living-donor nephrectomy and transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy groups in terms of mean duration of warm and cold ischemia, operation time, length of hospital stay, arterial anastomoses, visual analog scale pain scores, serum creatinine levels, and receiver outcomes, whereas a significantly higher number of venous anastomoses was noted in the laparoscopic living-donor nephrectomy group than in the transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy group ($P = .029$).

Conclusions: Transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy seems to be a feasible and reproducible alternative to conventional laparoscopic living-donor nephrectomy in female donors provided the viability of the vagina as an organ retrieval route.

Key Words: Laparoscopy approach, Living-donor nephrectomy, Transvaginal laparoscopy.

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INTRODUCTION

Being associated with similar graft function, a similar graft loss rate, similar surgical complications, similar graft survival, and a similar mortality rate^{1,2} while having significantly lower analgesic use, a quicker recovery, and a shorter hospital stay than open nephrectomy,^{3,4} laparoscopic living-donor nephrectomy (LLDN) has been widely accepted as a gold-standard method for kidney procurement.⁵ Because of improvements in donor morbidity with the introduction of laparoscopic surgery, a considerable increase occurred in the living-donation rate.⁶

With the advent of laparoscopic experience, technique, and instruments, less invasive methods have been developed. Minimally invasive new laparoscopic techniques, such as natural orifice transluminal endoscopic surgery (NOTES) and laparoendoscopic single-site surgery (LESS), have recently been described as aiming at reducing morbidity further by avoiding surgical incisions and external scars.⁷ The LESS technique is a great step for scarless surgery, and several studies confirmed its eligibility for donor nephrectomy.^{8,9} LESS by the umbilicus results in minimal scars. However, postoperative pain and incisional hernia have been considered likely in this procedure because of the need for at least a 5- to 6-cm linea alba incision for kidney extraction. Thus efforts to reduce these risks oriented surgeons toward another natural orifice, the vagina.

In this article we describe our first-year experience with transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy (TVNALDN) and compare the outcomes with those of conventional LLDN performed at our institution in terms of feasibility and reproducibility.

METHODS

Selection and Description of Participants

A total of 115 consecutive female patients who underwent LLDN (n = 70) or TVNALDN (n = 45) at the Organ Transplantation Center, Acibadem International Hospital, Istanbul, Turkey, between June 2012 and June 2013 were

included in this retrospective study. Female subjects with at least 1 live birth history were offered TVNALDN, and those who gave written informed consent after receiving a detailed explanation of the gynecologic and urologic complications of the operation and were approved by the gynecology department after preoperative gynecologic examination underwent TVNALDN. The other patients were operated on by LLDN.

Detailed preoperative evaluations of all patients were carefully performed. Both of the kidneys and the other intra-abdominal organs were examined by abdominal ultrasonography. Computed tomography angiography was used to examine the renal vascular anatomy. Renal function and the glomerular filtration rate were measured with a renal nuclear perfusion scan. The kidney with better function was left in the donor; however, left-sided nephrectomy was preferred in case of a renal function difference not $>5\%$. In the presence of multiple arteries, the side of the single artery was preferred, whereas left-sided nephrectomy was performed if both kidneys had double arteries and if the renal function difference was not $>5\%$. The operation was performed by an experienced surgeon with individual experience of >300 LLDNs.

Technical Information

After anesthesia induction and placement of a Foley catheter, the patient was placed in the 45° flank-up position and fixed to the operating table with adhesive bands. TVNALDN patients were placed with the legs separated to allow vaginal access. The abdomen, external genitalia, and vagina were prepared using povidone-iodine solution, and the patient was draped to include these areas. Thereafter a trocar (Ethicon Endo-Surgery, Cincinnati, Ohio) was placed 4 cm below the umbilicus and at the lateral aspect of the rectus muscle by an open technique. Insufflation was then performed, and a pneumoperitoneum of 12 mm Hg was induced. A 10-mm camera port was placed 2 cm lateral to the umbilicus; a 5-mm working port was placed 2 cm below the 12th rib along the midclavicular line; and a working port, used to suspend the ureter, was placed 4 cm below the 12th rib along the anterior axillary line. A 10-mm port was preferred for the retraction of the liver on the right side. After the port placement, Todd's fascia was opened, and the colon was mobilized to the medial aspect and moved away from the kidney. The ureter was identified and suspended. The Gerota fascia was opened, and the upper pole of the kidney was separated from the adrenal gland by dissection. The gonadal, adrenal, and lumbar venous branches were exposed at the point where they

joined the renal vein and were then cut by sealing with LigaSure (Valley Lab, Boulder, Colorado). The renal vein and renal artery (both renal arteries in the presence of double arteries) were cautiously dissected and exposed to gain the maximum possible length. After release of its lateral ligaments, when only the renal vascular structures remained, the peritoneum was exposed by cutting the layers with an approximately 6-cm inguinal incision, and it remained intact in LLDN patients. In TVNALDN patients a colpotomy compatible with the kidney size was created through the posterior fornix, and an Endobag (Covidien, Mansfield, Massachusetts) was inserted. The ureter was clipped with a Hem-o-Lok clip (Weck Closure Systems, Research Triangle Park, North Carolina) and sectioned. The renal vein and artery (or arteries) were cut together using a 30-mm vascular stapler (Multifire Endo TA 30 Stapler; Covidien) by obtaining the maximum length after kidney retraction; the peritoneum was released, and the kidney was removed through the inguinal incision from LLDN patients. In TVNALDN patients the kidney was removed transvaginally with an Endobag to eliminate possible contamination of the kidney. After closure of the peritoneal opening and colpotomy transvaginally, the abdomen was reinsufflated, a drain was inserted following control of bleeding and the incisions were closed in anatomic layers.

Postoperative Care

The patients were allowed to drink water in the evening of the operation day and have a light breakfast the following morning. The patients then ambulated. Patient-controlled analgesia and acetaminophen (paracetamol) were used as analgesics on demand. Vaginal packs and Foley catheters were removed on the first postoperative day. All patients received a single dose of first generation cephalosporin before the operation.

Assessment of Sexual Dysfunction

Female sexual dysfunction was assessed based on a psychiatric evaluation performed in the postoperative period according to criteria defined by the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*¹⁰ and Second International Consensus of Sexual Medicine.¹¹

Statistical Techniques

Statistical analysis was performed using computer software (SPSS, version 15.0; SPSS, Chicago, Illinois). Two-group comparisons for numerical variables were performed by use of the Student *t* test if normal distribution

Table 1.
Donor and Receiver Characteristics in Laparoscopic Versus Transvaginal Nephrectomy Groups

	LLDN ^a (n = 70)			TVNALDN ^a (n = 45)			P Value
	Mean (SD)	Median (Minimum-Maximum)	n (%)	Mean (SD)	Median (Minimum-Maximum)	n (%)	
Donor characteristics							
Age (y)	48.2 (12.2)	48 (26–75)		46.9 (11.0)	46 (30–78)		.559
BMI ^a (kg/m ²)	30.5 (5.2)	31 (20.5–41.0)		30.3 (4.1)	30 (22.5–39.9)		.998
PO ^a serum creatinine (mg/dL)	0.60 (0.12)	0.60 (0.29–0.93)		0.60 (0.10)	0.60 (0.42–0.78)		.069
Obesity (BMI ≥30 kg/m ²)			37 (52.9)			23 (51.1)	.855
Operation side							<.001 ^b
Right			37 (52.9)			5 (11.1)	
Left			33 (47.1)			40 (88.9)	
Abdominal operation history			28 (40.0)			12 (26.7)	.143
Receiver characteristics							
Gender							.363
Male			55 (78.6)			32 (71.1)	
Female			15 (21.4)			13 (28.9)	
Age (y)	39.1 (16.2)	38 (2–76)		36.2 (15.4)	33 (4–62)		.346

^aBMI = body mass index; LLDN = laparoscopic living-donor nephrectomy; PO = postoperative; TVNALDN = transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy.

^bStatistically significant.

criteria were fulfilled and by the Mann-Whitney *U* test for data with an abnormal distribution pattern. For the comparison of ratios for categorical variables, χ^2 tests were used. Data were expressed as mean (standard deviation), minimum and maximum, and percent where appropriate. The level of statistical significance was set at $P < .05$.

RESULTS

Donor Characteristics

A total of 70 female donors (100.0%) (mean age, 48.2 years [SD, 12.2 years]) who underwent LLDN and 45 female donors (100.0%) (mean age, 46.9 years [SD, 11.0 years]) who underwent TVNALDN on their admission to the hospital were consecutively included in the study. There was no significant difference between LLDN and TVNALDN donors in terms of mean values (standard deviations) for

age, body mass index (in kilograms per square meter), and postoperative serum creatinine levels, as well as percent of obesity and history of abdominal surgery (**Table 1**). Left-sided nephrectomy was significantly more frequent among TVNALDN patients than LLDN patients (88.9% versus 47.1%, $P < .001$) (**Table 1**).

Receiver Characteristics and Operative Outcomes

Receivers from LLDN donors (mean age, 39.1 years [SD, 16.2 years]; 78.6% of whom were men) and TVNALDN donors (mean age, 36.2 years [SD, 15.4 years]; 71.1% of whom were men) were homogeneous in terms of mean age (standard deviation) and gender distribution (**Table 1**).

Neither visual analog scale pain scores measured at discharge nor serum creatinine levels at discharge, at the sixth postoperative month, and at the 12th postoperative month differed significantly between the LLDN and TVNALDN groups (**Table 2**).

Table 2.
Operative Characteristics and Receiver Outcomes in Laparoscopic Versus Transvaginal Nephrectomy Groups

	LLDN ^a (n = 70)			TVNALDN ^a (n = 45)			P Value
	Mean (SD)	Median (Minimum- Maximum)	n (%)	Mean (SD)	Median (Minimum- Maximum)	n (%)	
Transplantation							
Warm ischemia (s)	176.5 (61.3)	165 (77–414)		182.5 (38.9)	177 (112–261)		.193
Cold ischemia (min)	42.0 (15.1)	42 (19–91)		41.1 (10.7)	41.5 (24–69)		.965
No. of arterial anastomoses	1.2 (0.4)	1 (1–2)		1.2 (0.4)	1 (1–2)		.342
No. of venous anastomoses	1.1 (0.4)	1 (1–3)		1.0 (0.0)	1 (1–1)		.029
Donor operation time (min)	151.4 (25.2)	150 (100–210)		156.7 (30.4)	150 (110–270)		.503
Length of hospitalization (d)	2.7 (0.4)	2 (2–5)		2.7 (0.5)	2 (1–5)		.973
VAS ^a pain score at discharge (0–10)	2 (0.5)	2 (1–6)		1.5 (0.5)	1.5 (1–5)		.786
Serum creatinine (mg/dL)							
At discharge	1.36 (0.50)	1.31 (0.35–3.42)		1.24 (0.54)	1.22 (0.31–3.62)		.852
6 mo postoperatively	1.49 (0.58)	1.39 (0.41–3.03)		1.40 (0.67)	1.19 (0.72–3.25)		.159
12 mo postoperatively	1.35 (0.41)	1.34 (0.44–2.27)		1.35 (0.63)	1.12 (0.76–2.32)		.734
Receiver outcome							
Major complication			1 (1.4)			2 (4.4)	.560
Graft loss ^b			2 (2.9)			0 (0.0)	.519
Death			2 (2.9)			0 (0.0)	.519

^aLLDN = laparoscopic living-donor nephrectomy; TVNALDN = transvaginal natural orifice transluminal endoscopic surgery–assisted living-donor nephrectomy; VAS = visual analog scale.

^bOne of these patients has died and therefore is also listed in the “Death” category.

The mean number of venous anastomoses (standard deviation) was significantly higher among receivers from LLDN donors than receivers from TVNALDN donors ($P = .029$), whereas the 2 groups were similar in terms of arterial anastomoses (**Table 2**). No significant difference was detected between groups in terms of duration of hot and cold ischemia, operation time, and length of hospital stay (**Table 2**).

Receiver Outcomes

On follow-up, 2 graft losses were recorded. One occurred as a result of venous thrombosis, and the other was due to focal segmental glomerulosclerosis recurrence, which resulted in the death of the patient. Another receiver was lost because of pulmonary embolism. All cases with graft loss or death were in the LLDN group, whereas no significant difference between groups was noted in terms of the incidence of graft loss and death (**Table 2**).

DISCUSSION

From dialysis treatment and cadaveric renal transplantation to live-donor transplantation, there has been tremendous development in the management of end-stage renal disease along with the radical transformation in kidney surgery during the past 2 decades.^{12,13}

Because it is performed in healthy persons, kidney donation represents a special situation necessitating maximum effort to minimize the surgical risk and morbidity of the individuals.¹⁴ Hence the introduction and progression of minimally invasive techniques such as LESS and TVNALDN has led to new options for donor nephrectomy.

The NOTES approach was reported to avoid large skin incisions, thus reducing postoperative pain, preventing abdominal hernia development, and improving cosmetic results with an earlier recovery.¹⁵ Although a unique robotic approach completed with pure vaginal NOTES was described

by Pietrabissa et al,¹⁶ difficulty of dissection was concluded as a restricting factor in pure NOTES donor nephrectomy because of the flexibility of the instruments used, which prevents proper retraction and limits the access for good hemostatic devices.¹⁷ So-called hybrid NOTES, combining NOTES access and a minimum number of the possible abdominal trocars, has been developed to overcome these limitations.¹⁷ As a hybrid NOTES approach, LLDN with vaginal extraction in which only the removal of the kidney is carried out from the vagina is a relatively new approach with a limited number of studies in the literature.¹⁸

The first reported case of the vaginal approach in living-kidney donor surgery was a 48-year-old woman who donated her kidney to her 23-year-old niece. In that particular study, reported by Allaf et al¹⁹ in 2010, the operative time was reported to be 185 minutes, the patient was discharged within 24 hours, and the recipient parameters were reported to be excellent after 11 months' follow-up. Then, the largest series of TVNALDN was first reported by Alcaraz et al⁶ in 2011, in which 20 patients underwent TVNALDN. They reported no significant differences between the TVNALDN group and the conventional LLDN group in terms of the operative variables; the longer warm ischemia time in the TVNALDN group was considered acceptable because placing the kidney in an Endobag is sometimes problematic. Eroğlu et al²⁰ presented 7 cases with similar success besides better cosmesis and less postoperative pain in the TVNALDN group. Kaouk et al²¹ successfully performed robotic hybrid donor nephrectomy by only using the natural 2 openings including the vagina and umbilicus.

Our technique was similar to that defined by Alcaraz et al⁶ with use of the transvaginal approach as a working port during the whole procedure, thus avoiding the need for a fourth abdominal trocar insertion and placement of the kidney inside the EndoCatch device (Covidien) before clipping it, which was reported to reduce the warm ischemia time.

On the basis of our first-year experience with TVNALDN in living donors aiming to evaluate the feasibility of a variation of NOTES using the transvaginal route while maintaining the philosophy of NOTES,²² we consider LLDN and TVNALDN to have comparable findings in terms of operative characteristics (hot/cold ischemia time, number of arterial anastomoses, donor operation time), length of hospitalization, serum creatinine levels, pain score at discharge, and receiver outcomes (major complication, graft loss, death), whereas a significantly higher number of venous anastomoses were noted in the TVNALDN group.

Along with the presence of similar donor and recipient baseline characteristics in the 2 groups and no evidence of postoperative sexual dysfunction in the TVNALDN group, our

findings indicate that TVNALDN offers a safe and scarless surgical alternative to conventional LLDN in female living donors with faster postoperative healing, a tendency for lower pain scores at discharge, and maintenance of normal sexual function. In addition, it seems also to be an alternative to LESS in female living donors by means of avoiding abdominal incisions for the extraction of the organ.^{6,23}

The significantly higher number of venous anastomoses in the LLDN group when compared with the TVNALDN group may be explained by our preference for LLDN instead of TVNALDN in cases with multiple veins because of the probability of a shorter warm ischemia time with LLDN. However, with more experience, we considered that the vein and artery count formed no contraindication to TVNALDN. Notably, selection of operation type based on a similar concern yielded no difference between groups in case of the presence of multiple arteries.

Although the possibility of postoperative sexual dysfunction raises a concern about the vaginal living-donor nephrectomy (LDN) approach, current literature on this topic, mainly in the gynecologic field, suggests that sexual dysfunction is a rare event after vaginal surgery.²⁴ Accordingly, when female donors were evaluated for sexual dysfunction in the first postoperative month in our study, they identified no change in sexual function or reluctance in sexual life since surgery. Moreover, the patients, most of whom were mothers donating their kidneys to their children, were very satisfied and had expressed feelings of giving birth to them again. This finding is quite consistent with a report showing no evidence of sexual dysfunction along with no change in the sexual life of female patients who underwent TVNALDN operations and who expressed that they all were satisfied and would recommend this approach in a previous study by Alcaraz et al.⁶

Similar success in reducing morbidity in living donors has also been reported for the LESS technique—being another new minimally invasive laparoscopic technique that avoids surgical incisions and external scars—in LDN when compared with conventional LLDN.^{25–27} The first LESS live-donor nephrectomy performed through the navel was described by Gill et al²⁸ in 2008, with no differences compared with conventional LLDN regarding the need for postoperative analgesia and length of hospitalization, whereas the LESS group donors had a shorter period of convalescence and return to work, showing better satisfaction with regard to esthetic results. A higher warm ischemia time in LESS patients was reported to have no impact on the graft function.²⁵ Several other groups have published their initial experiences with live-donor LESS nephrectomies using a Pfannenstiel

incision²⁹ or different devices, such as the GelPOINT (Applied Medical, Rancho Santa Margarita, CA, USA) device placed at the navel,³⁰ or the Quadport/Triport (Advanced Surgical Concepts, Ireland) device,³¹ confirming the reproducibility of the surgical technique and good esthetic results.¹⁴

However, LESS has been reported to be associated with technical difficulties inherent to the procedure, including loss of triangulation and sense of depth, collision of instruments, difficulty in organ retraction, and the need to cross the surgeon's hands.¹⁴ Careful selection of patients tributary to this type of surgery has been recommended, along with caution regarding performing it in patients with a history of surgery and obese patients (body mass index >30 kg/m²).³²

Hence, although the application of both the NOTES- and LESS-based surgical techniques in live-donor nephrectomy seems very promising and LESS allows for the performance of the operation through a single incision with the consequent reduction in morbidity and improved esthetic results, in the case of women, hybrid NOTES transvaginal surgery has been considered a very promising technique that offer great advantages by avoiding abdominal incisions for the extraction of the organ, achieving excellent esthetic results and probably a lower rate of morbidity for the individual.^{6,14,23}

The viability of the vagina as an organ retrieval route was reported by Alcaraz et al,⁶ in their series of TVNALDN, as the most important requirement for candidates for transvaginal LDN. Because an elastic and distensible vagina, as assessed by digital palpation, that would allow safe organ extraction was indicated likely to be enough to offer this approach, previous vaginal deliveries were not considered an absolute requisite.⁶

Likewise, we also consider preoperative gynecologic examination mandatory. Although we initially preferred to include multiparous women for the procedure, with more experience, we even included women with a gynecologic operation history in the TVNALDN group.

In addition, on the basis of our experience, we recommend repeating the povidone-iodine scrub for the vagina 10 minutes before kidney extraction to prevent infectious complications. We also suggest that meticulous care should be taken to prevent damage to the Endobag during extraction. We consider that colpotomy must be adequate in length; otherwise, this factor would require additional time, whereas the use of a vaginal retractor seems to facilitate a satisfactory opening.

Given the similar graft function and surgical complication rates, TVNALDN seems to be a technique that could allow the surgeon to avoid the abdominal 6- to 7-cm incision for

kidney extraction, and it has proven functional and cosmetic benefits, which justify the implementation of scarless surgery in kidney donation. Accordingly, our findings emphasize that TVNALDN would be helpful in overcoming the major challenge of transplantation surgery, which is to minimize morbidity in the donor population while maintaining graft outcomes.⁶

Albeit challenging new techniques are still under investigation, the natural orifices seem to be the major gates for surgeons in the future, with likely use of other natural orifices in surgical operations based on data provided from animal models.^{33–37}

CONCLUSIONS

On the basis of associated reduction in morbidity and better cosmetic results, which help increase the rate of donation, as well as no evidence of sexual dysfunction in operated donors, TVNALDN seems to be a feasible and reproducible alternative to conventional LLDN in female donors provided the viability of the vagina as an organ retrieval route. In our opinion, hybrid NOTES procedures are steps toward to pure NOTES, which seems inevitable given the advances in robotic technology and the transition of surgical experience.

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