



# Transumbilical laparoendoscopic single-site donor nephrectomy: evolving trends

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Received: 4 April 2018 / Accepted: 20 September 2018 / Published online: 26 September 2018  
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## Abstract

**Background** We report our experience with laparoendoscopic single-site donor nephrectomy (LESS DN).

**Methods** Retrospective comparative study of data from 200 Consecutive left LESS DN (group A) compared to 205 consecutive conventional laparoscopic donor nephrectomy (LDN) (group B). Standard laparoscopic instruments were used in all patients. Right nephrectomies were excluded.

**Results** From 05/2015 to 12/2017, 200 LESS DN (group A) and from 10/2011 till 04/2015, 205 LDN (group B) were performed. In group A and B, respectively, the mean operative time was  $175.9 \pm 24.9$  versus  $199.88 \pm 37.06$  min ( $p=0.0001$ ), the mean warm ischemia time was  $5.2 \pm 1.02$  versus  $3.64 \pm 1.38$  min ( $p=0.0001$ ), the mean BMI was  $24.8 \pm 4.5$  versus  $25.2 \pm 4.7$  kg/m<sup>2</sup>, complex vascular anatomy was found in 60 (30%) and 68 (33.2%), average length of incision was 5.2 versus 7.7 cm ( $p=0.001$ ), scar satisfaction rate 8 versus 6 ( $p=0.004$ ), mean morphine equivalents 81.0 versus 70.5 mg; ( $p=0.03$ ), average timing for return to work was 42 versus 50 days; ( $p=0.001$ ). There was no conversion to open surgery in both groups. One case converted to hand-assisted laparoscopic nephrectomy in group A. Pure LESS-DN was successfully completed in 169 patients (84.5%). In group A, due to technical difficulties, additional 1 or 2, 5-mm port(s) was added in 21 and 10 cases, respectively. Two negative explorations were performed in the first post-operative week for picture of small bowel obstruction. We had port site hernia in one donor, superficial wound infection in three donors and blood transfusion was required in two donors in group A.

**Conclusions** Our experience with LESS-DN is encouraging. LESSDN can be integrated as a standard approach for renal donation without additional donor risk. Moreover, LESS DN gives more flexibility by possibility to add one or more 5-mm ports in case of technical difficulties.

**Keywords** Transumbilical laparoendoscopic single-site · Donor nephrectomy

Laparoscopy offers the donor a smaller incision, and in turn, less surgical trauma, ensuring less post-operative pain, and quicker recovery and return to work; therefore, people's

tendency to become live donors increases [1]. Laparoscopic donor nephrectomy (LDN) has become an established method of organ harvesting [2–7].

Laparoendoscopic single-site donor nephrectomy (LESS DN) represents a valid alternative in the care of living donors. LESS DN has been recently introduced as an attempt to further improve cosmetic benefits and reduce the morbidity for potential kidney donors, there have been multiple comparative studies on this, including small RCTs and systematic reviews [8–14].

Moreover, LESS-DN was associated with less pain, lower analgesic requirements, shorter length of hospital stay (LOS), quicker recovery [15], and more patient satisfaction [16]. Our transplant program is one of the busiest centers in the Middle East region; 204 renal transplants were

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performed here last year. About 95% of transplants are from living donors, more than 85% of them from related donors. All donations are unpaid. The aim of this study was to present our initial LESS DN experience.

## Methods

### Study design

This is a retrospective comparative chartreview study of 200 consecutive LESS DN performed during the period between May 2015 till December, 2017 (group A) and 205 consecutive conventional laparoscopic donor nephrectomies that were performed during the period between November 2011 and April 2015 (group B). Standardized donor selection and management were followed. Right-side nephrectomies were excluded as by definition they required one or two extra ports. Donor and recipient medical records were reviewed, after approval from the Institutional Review Board.

### Definition

Warm ischemia time was defined as the time between the application of the first laparoscopic surgical stapler on the renal artery and the initiation of cold perfusion of the kidney on the bench [10].

### Donors evaluation and management

All donors underwent in-depth preoperative pre-transplant medical, psychosocial, and financial evaluation and testing by a multidisciplinary team before the decision was made to proceed with the donation. Donors underwent computed tomographic angiography, to evaluate hilar vascularity, as well as the presence of any abnormalities.

Information that was collected and analyzed included epidemiological data, LESS-DN and LDNpre-, intra- and post-operative parameters, including pre- and post-operative donor renal function, operative time, warm ischemia time, blood loss, transfusion rate, the effect of the learning curve, delayed graft function, length of stay, pain score and complications [short term (within a month) and long term (within a year)] after nephrectomy. Visual analogue pain score (on scale 1–10) was used. Scar satisfaction questionnaire was administered 6, 9, and 12 months after surgery, ranging from 0 = unsatisfied to 10 = very satisfied [17].

### Post-operative follow-up

We see the donors every 2 weeks for a month then every 3 month for a year. In each visit, we perform complete

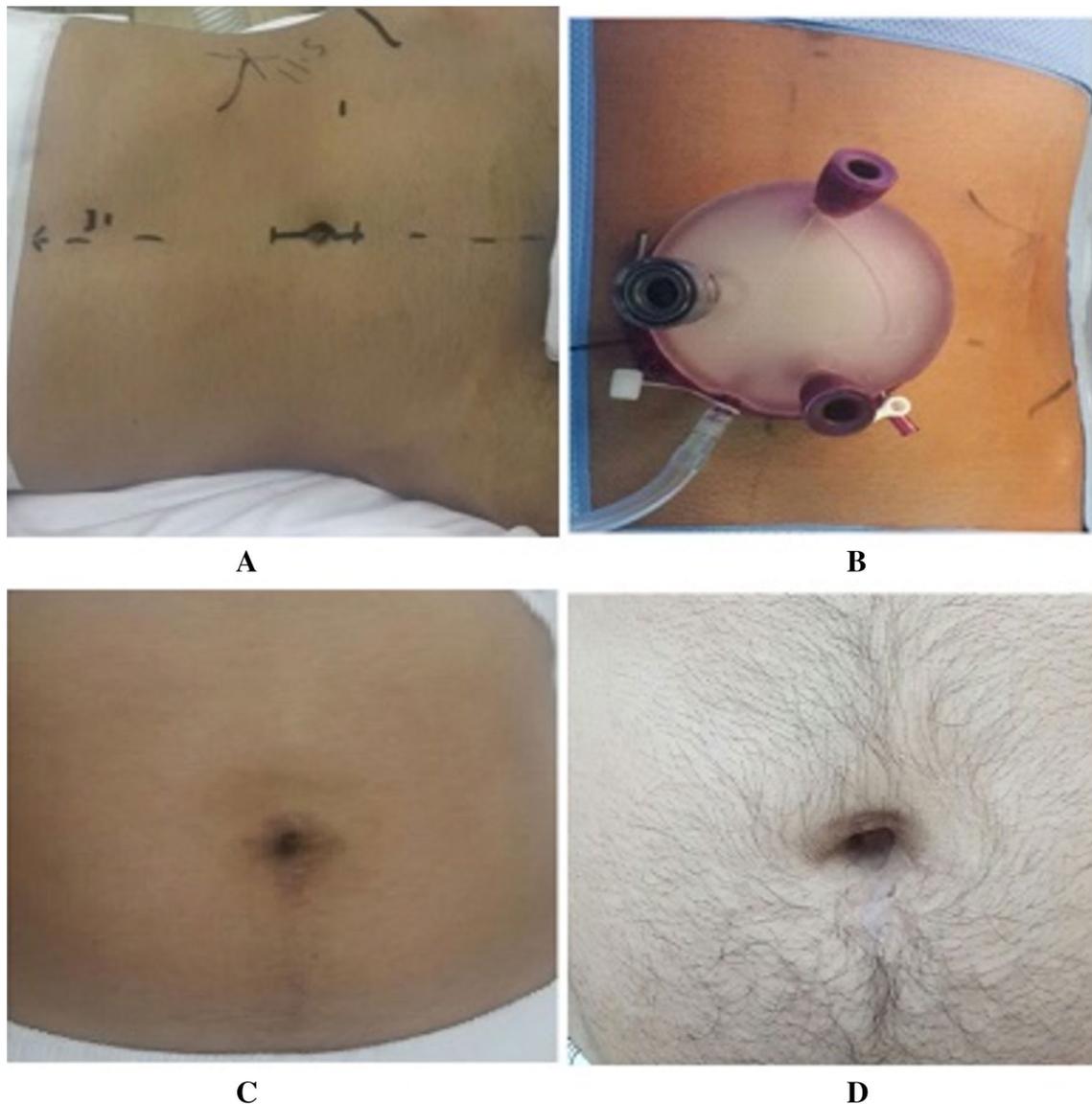
physical examination and check vitals, weight, renal profile, and eGFR using Modification of Diet in Renal Disease equation.

### Statistical analysis

Data were placed on an SPSS 15.0 (SPSSinc., Chicago, IL) spreadsheet for analysis. We used Chi-squared and Student's *t* test to compare categorical and continuous variables, respectively. Statistical significance was set at  $p < 0.05$ , and all reported *p* values are two sided [17]. Categorical data were summarized as proportions and percentages and continuous data were summarized as means and standard deviations [18].

### Surgical technique

Informed consents were obtained from all donors after explaining to them that LESS DN is not the gold standard technique for donor nephrectomy beside the longer median operative time compared to LDN. We offered both techniques to all donors. All LESS DN were performed by single transplant surgeon. The donors were prepared for surgery in a 45° flank position. As regard conventional LDN, we used 12-mm port for the camera [10 mm], 45° camera [Karl Storz™], 5 mm subcostal and 15 mm left iliac fossa working ports, we extract the kidney through Pfannenstiel incision via endobag. Regarding LESS DN (Fig. 1), the upper and lower edges of the skin incision are marked 1 cm above and below the umbilicus. 5-cm-long vertical transumbilical incision is made. The abdominal cavity was entered, passing the layers through a transumbilical incision on the kidney side, and the GelPoint (Applied Medical, Rancho Santa Margarita, CA) was subsequently placed, followed by the insertion of one 12-mm and two 10-mm trocars through the port. In addition, standard laparoscopic instruments and a 30° angled camera system were used in the operations. The basic conventional LDN steps were followed after entering the abdomen. The white line of Toldt was incised and the colon was mobilized medially. The ureter and gonadal vessels were identified, and dissection was continued proximally, toward the renal hilum. The adrenal vein was identified and ligated using LigaSure (Valleylab Inc., Boulder, CO), and the upper pole was subsequently freed. The renal artery and vein were skeletonized until adequate length was achieved. Finally, the posterior attachments were released. The 12-mm port then was replaced with 15-mm port to fit the retrieval endobag. After being informed that the recipient was ready, the ureter, the renal artery and vein were cut with Multifire Endo GIA 35 mm stapler (US Surgical Corporation, Norwalk, CT). Then the



**Fig. 1** A Incision, B GelPoint with ports, C and D post-operative scars

graft was removed via retrieval bag. The port was subsequently re-inserted for hemostasis control. There was no need for drainage in any of the patients. All layers were then closed and the operation was completed [10].

## Results

From 05/2015 to 12/2017, 200 LESS DN (group A) and from 10/2011 till 04/2015 205 LDN (group B) were performed. Average follow-up period was 18 and 54 months in group A and B, respectively.

## General outcome in both groups

All donors were admitted one day before surgery. In group A and B, respectively, the mean operative time was  $175.9 \pm 24.9$  versus  $199.88 \pm 37.06$  min ( $p = 0.0001$ ), the mean warm ischemia time (WIT) was  $5.2 \pm 1.02$  versus  $3.64 \pm 1.38$  min ( $p = 0.0001$ ), the mean body mass index (BMI) was  $24.8 \pm 4.5$  versus  $25.2 \pm 4.7$  kg/m<sup>2</sup>, average length of incision was 5.2 versus 7.7 cm ( $p = 0.001$ ), scar satisfaction rate 8 versus 6 ( $p = 0.004$ ), mean morphine equivalents 81.0 versus 70.5 mg; ( $p = 0.03$ ), average LOS  $3.5 \pm 1.4$  versus  $3.7 \pm 1.5$  days ( $p = 0.249$ ), average timing for return to work was 42 versus 50 days; ( $p = 0.001$ ). Average timing

for return to work was 42 versus 50 days; ( $p = 0.001$ ). The mean serum creatinine levels were  $1.28 \pm 0.43$  versus  $1.24 \pm 0.32$  mg/dl,  $1.2 \pm 0.73$  versus  $1.16 \pm 0.64$  mg/dl,  $1.23 \pm 0.19$  versus  $1.25 \pm 0.53$  mg/dl and  $1.13 \pm 0.05$  versus  $1.13 \pm 0.26$  mg/dl at 3, 30, 90, and 365 days after donation in group A and B, respectively (Table 1).

### Extra port insertions and conversion rates

In group A, due to technical difficulties in mobilization of upper pole of kidney and/or retraction of bowels to expose the renal hilum, additional 1 or 2, 5-mm port(s) was added in 21 and 12 cases, respectively. We considered addition of two ports a conversion to laparoscopy. LESS-DN was successfully completed in 169 patients (84.5%). 70% of extra port/s was required only during first 3 months after starting LESS DN (learning curve effect). However, there was no significant effect of learning curve on OR time in LESS DN group (Table 2). One case converted to hand-assisted laparoscopic nephrectomy.

There was no conversion to open surgery in both groups.

*Complex renal vascular anatomy* [multiple renal arteries, multiple renal veins, retroaortic renal veins, circumaortic veins, left sided IVC] was found in 60 (30%) and 68 (33.2%), in group A and B, respectively, multiple renal arteries were found in 23.6% and 22.4%, multiple renal veins were found in 14.5% and 3.9%, retroaortic veins were found in 5% and 5.8%. One circumaortic vein and two left sided IVC were found in group B (Table 1).

### Blood loss and blood transfusion

Average blood loss was 60 versus 50 mL ( $p = 0.41$ ) and blood transfusion was required in two donors in group A [Clavien–Dindo Classification grade II].

### Post-operative complications

In group A, two negative explorations were performed in the first post-operative week for picture of small bowel

**Table 1** LESS DN versus LDN

Donor (mean $\pm$ SD)	LESS-DN	LDN	<i>p</i> value
Number	200	205	
Age	30.2 $\pm$ 7.5	28.8 $\pm$ 6.7	0.008
Sex			
M	138	158	
F	62	47	
BMI	24.8 $\pm$ 4.5	25.2 $\pm$ 4.7	0.465
Two arteries	45	43	
Three arteries	1	3	
Two veins	16	8	
Three veins	1	0	
Retroaortic veins	6	12	
Circumaortic vein	0	1	
Left IVC	1	1	
OR time (mins)	175.9 $\pm$ 24.9	199.88 $\pm$ 37.06	0.0001
WIT (mins)	5.2 $\pm$ 1.02	3.64 $\pm$ 1.38	0.0001
Serum creatinine			
On discharge	1.28 $\pm$ 0.43 mg/dl	1.24 $\pm$ 0.32 mg/dl	0.35
1 months	1.2 $\pm$ 0.73 mg/dl	1.16 $\pm$ 0.64 mg/dl	0.615
3 months	1.23 $\pm$ 0.19 mg/dl	1.25 $\pm$ 0.53 mg/dl	0.0001
1 year	1.13 $\pm$ 0.05 mg/dl	1.13 $\pm$ 0.26 mg/dl	1.00
Length of hospital stay (days)	3.5 $\pm$ 1.4	3.7 $\pm$ 1.5	
Conversion to open	0	0	0.249
Incision length (cm)	5.2	7.7	0.001
Readmission	1	0	
Reoperation	3	1	
Wound infection	1	0	
Bowel obstruction	1	0	
Incisional hernia	1	1	
Mortality	0	0	

**Table 2** LESS DN

Donor (mean $\pm$ SD)	Pure single site	Single + 1 port	Single + 2 ports	<i>p</i>
Number	169 (84.5%)	21 (10.5%)	10 (5%)	
Age	30.5 $\pm$ 7.6	32.6 $\pm$ 7.1	33.4 $\pm$ 7.5	0.364
M	103 (75%)	19 (14%)	16 (11%)	
F	52 (84%)	8 (13%)	2 (3%)	
BMI	25.75 $\pm$ 4.6	29.12 $\pm$ 2.4	28.73 $\pm$ 4.2	0.019
Two arteries	31	9	5	
Three arteries	1	0	1	
Two veins	13	1	2	
Three veins	1	0	0	
WIT (mins)	4.99 $\pm$ 1.02	5.52 $\pm$ 1.58	5.73 $\pm$ 16.14	0.357
OR time (mins)	208.21 $\pm$ 71.33	215 $\pm$ 42.16	273.57 $\pm$ 73.86	0.041

obstruction [*Clavien–Dindo Classification grade III b*], one donor in group B had post-operative bowel obstruction and exploratory laparotomy revealed internal herniation [*Clavien–Dindo Classification grade III b*]. One patient in group A cohort had umbilical hernia that required surgical repair [*Clavien–Dindo Classification grade III b*]. No readmission or wound complications found in group B. However, In Group A, three donors (2.7%) had surgical site infections that treated conservatively [*Clavien–Dindo Classification grade II*]. Two capsular tears occurred in group A during extraction through short incision and managed conservatively [*Clavien–Dindo Classification grade I*].

Fifteen patients (13.6%) and 22 patients (10.7%) had residual loin and/or left testicular pain that improved with time and without medications in group A and B, respectively [*Clavien–Dindo Classification grade I*].

### Recipients' outcome

In group A and B, respectively, recipients mean age was 40.7  $\pm$  15.1 versus 40.3  $\pm$  15.3 ( $p = 0.824$ ), mean BMI 25.7  $\pm$  6.3 versus 24.5  $\pm$  5.6 ( $p = 0.084$ ), preemptive transplantation 8% versus 11.7%, IGF 90% versus 91.2%, SGF 9% versus 5.3%, DGF 0.9% versus 2.9%, primary non-function 0% versus 0.48%, graft loss 0.9% versus 2.9%, DWFG 0.9% versus 1.5%, Basiliximab was used as induction immunosuppression in 80% versus 92% while Thymoglobulin was used in 20% versus 8% high immunological risk recipients [previous transplantation, high PRA, and desensitization protocol], eGFR on 1 year 88  $\pm$  18.2 versus 83  $\pm$  12.2 mL/min/1.73 m<sup>2</sup> ( $p = 0.004$ ). The mean serum creatinine levels were 1.3  $\pm$  0.93 versus 1.4  $\pm$  1.2 mg/dl, 1.1  $\pm$  0.33 versus 1.2  $\pm$  0.75 mg/dl, 1.05  $\pm$  0.29 versus 2.2  $\pm$  0.48 mg/dl, and 1.05  $\pm$  0.25 versus 1.1  $\pm$  0.39 at 7, 30, 90, and 365 days after transplantation, respectively. 1-year graft survival was 94% versus 95.7%, and 1-year patient survival was 97.4% versus 97.2% in group A and B, respectively.

### Discussion

Raman et al. reported the first LESS-DN in 2007 [19]. Afterward in 2008, Gill et al. established its possibility for donor nephrectomy through an intra-umbilical incision a novel single access tri-lumen R-port [8]. Notably, LESS-DN has been associated with longer mean operative time attributable to the learning curve with instrument clashing and prolonged warm-ischemia time [9]. Moreover, the limited working space poses difficulty in LESS-DN because of the camera assistant and During traditional laparoscopy, the camera assistant and the cable of the laparoscopic vertical light source that could be overcome by using Bariatric laparoscopes [20]. Articulating equipment may be utilized to solve the lack of classic triangulation in LESS-DN. Actually, Ganpule et al. reported that use of articulating equipment prolong the learning curve [21]. Several technical modifications to LESS DN were reported. Leeser et al. described LESS DN using Gelpoint device [22]. While, Dubey et al. described Transumbilical LESS DN without the use of a single port access device in five patients. They used three standard laparoscopic ports (10 mm  $\times$  1, 5 mm  $\times$  2) which were placed through a 4.5-cm vertical transumbilical incision [2]. Moreover, addition of one or two extra ports in difficult or obese patients was reported in some studies [17]. In current study, the need for extra port insertion was obviously related to the learning curve as 70% of extra port insertions were reported during first 3 months of the study period. Moreover, it is related to male gender, high BMI and longer OR time.

The most challenging steps of LESS-DN are upper pole mobilization and graft retrieval. The authors have described a variety of methods for graft retrieval which include manual methods and those using retrieval bags (as in our study). In the majority of the studies, the graft retrieval time is longer in comparison to standard LDN. However, the graft outcome in recipients is comparable [21]. The graft could be extracted through Pfannenstiel incision [23] or transvaginal [24, 25] without additional intraoperative complications. Although

Pfannenstiel incision technique seems to cause fewer hernias compared with classic iliac extraction, it can have a significant local neuropathy [9]. In current study, freeing of the upper pole of the kidney was a challenging. We faced no problems with graft extraction through the transumbilical incision. In current study, the mean WIT in LESS DN group was  $5.2 \pm 1.02$ . The reported time of warm ischemia varies from 2.6 to 6.79 min [9, 21, 23, 26–29].

Few studies have compared the outcome of LESS DN to LDN. They reported that the LESS DN may be associated with less need for post-operative analgesics, and earlier transition to oral nutrition in the LESS-DN group, and recovery and return to work; 3 weeks in Gill et al. series, and 7 weeks with conventional laparoscopy. This decrease in convalescence time with a faster return to work can represent a socioeconomic advantage [9, 30]. There was no significant difference between LDN and LESS in terms of operative time, WIT, estimated blood loss, median length of stay, and total morphine equivalents [9, 23, 30, 31].

In current study, LESS group had shorter OR time, this may be due to Less BMI, less time needed for opening and closing the periumbilical incision in group A compared to classic Pfannenstiel incision (mean time for opening and closing was  $28 \pm 7$  min) in group A. Furthermore, we started LESS after long experience with conventional laparoscopic donor nephrectomy [205 cases]. We would offer Pfannenstiel incision and conventional LDN for donors who had previous C-section scars (none of our donors had prior C-section scars) and who refused the periumbilical incision. We think smaller periumbilical incision provided more patient satisfaction. Moreover, it is easier to open and close than Pfannenstiel incision that may shorten the total OR time.

Similarly, data from retrospective series indicated comparable, but not superior, outcomes for LESS DN compared with LDN in terms of measures of in-hospital morbidity and allograft outcomes [9, 32]. For example, Canes et al. [9] found that LESS DN was advantageous in terms of post-operative recovery, but the duration of warm ischemia was longer with LESS DN. They also reported that there was no difference in terms of allograft function in the early period. Furthermore, Wang et al. [33] reported that there were no significant differences in terms of perioperative results and allograft functions, and that the surgery durations were longer. However, they emphasized that better cosmesis and quicker recovery would be regarded as advantages. In our study, LESS DN group had less mean of WIT, BMI, incision length, and time to return to work. On other hand, it had more blood loss and analgesia requirements. Despite longer WIT in group A, there was no statistically difference in outcomes.

In our series, we are using only one OR; therefore, we started with donor nephrectomy followed by transplantation, average cold ischemia time  $2 \pm 0.5$  h. We used Gelpoint

device (Applied Medical systems, Rancho Santa Margarita, CA) and conventional laparoscopic instruments. LESS DN would be more difficult in obese donors and in donors with multiple vessels. Therefore, careful patient selection, with low BMI and single vessels is preferable during the learning curve period [10]. In current study, the main surgeon performed more than more than 300 conventional LDN before deciding to start LESS DN as he thought LESS DN could be a step forward in donor surgery. From 5/2015 till 12/2017, we performed only one technique (LESS DN); there was no selection bias for BMI. We did some right nephrectomies in case of complex vascular anatomy in left side. But we excluded right nephrectomies as by definition right LDN require insertion of one or two extra ports. Selection of left versus right depends on complexity of vascular anatomy and if there is any discrepancy in size and or volume of both kidneys. We do split function test in such cases, the right kidney was chosen if there was a 10% difference in renal split function.

In our cohort, transplantation outcome; renal functions, rejections, graft loss and surgical complications, were comparable between the groups during the first 18 months after transplantation.

## Conclusion

In our experience, LESS DN is feasible but more challenging, offers improved cosmesis, patient satisfaction, and may offer decreased pain. Further improvement in instrumentation is likely to expand its future role. LESS DN can be considered as an alternative approach for donor nephrectomy without additional donor risk.

**Author contributions** HMEH: designed the study, collected data, analyzed data, wrote the paper, performed the surgery. AAH: performed the surgery. NMK: performed the surgery. MMJ: performed the surgery. WTH: review the paper. ASAF: performed the surgery. AEF: performed the surgery.

## Compliance with ethical standards

**Disclosures** Hany M. El Hennawy, Ahmed Al Hashemy, Najib M. Kadi, Muhammed M. Jameel, Abdullah S. Al Faifi, Wael T. Habbab, Ahmed E. Fahmy declare that they have no conflict of interest.

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