

## ORIGINAL ARTICLE

# Optimizing left-sided live kidney donation: hand-assisted retroperitoneoscopic as alternative to standard laparoscopic donor nephrectomy

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## Keywords

hand-assisted retroperitoneoscopic donor nephrectomy, laparoscopy, live kidney donation, surgical technique.

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## Summary

Laparoscopic donor nephrectomy (LDN) is less traumatic and painful than the open approach, with shorter convalescence time. Hand-assisted retroperitoneoscopic (HARP) donor nephrectomy may have benefits, particularly in left-sided nephrectomy, including shorter operation and warm-ischemia time (WIT) and improved safety. We evaluated outcomes of HARP alongside LDN. From July 2006 to May 2008, 20 left-sided HARP procedures and 40 left-sided LDNs were performed. Intra and postoperative data were prospectively collected and analysis on outcome of both techniques was performed. More female patients underwent HARP compared to LDN (75% vs. 40%,  $P = 0.017$ ). Other baseline characteristics were not significantly different. Median operation time and WIT were shorter in HARP (180 vs. 225 min,  $P = 0.002$  and 3 vs. 5 min,  $P = 0.007$  respectively). Blood loss did not differ (200 ml vs. 150 ml,  $P = 0.39$ ). Intra and postoperative complication rates for HARP and LDN (respectively 10% vs. 25%,  $P = 0.17$  and 5% vs. 15%,  $P = 0.25$ ) were not significantly different. During median follow-up of 18 months estimated glomerular filtration rates in donors and recipients and graft- and recipient survival did not differ between groups. Hand-assisted retroperitoneoscopic donor nephrectomy reduces operation and warm ischemia times, and provides at least equal safety. Hand-assisted retroperitoneoscopic may be a valuable alternative for left-sided LDN.

## Introduction

In 2007, approximately 500 candidates for kidney transplantation died while being on the waiting list in the Eurotransplant countries and more than 4000 in the United States. In addition, a considerable number of patients were removed from the waiting list because their clinical condition for undergoing transplantation had deteriorated by the time their turn for allocation of organ came about [1,2].

Live kidney donation is an important alternative for patients with end-stage renal failure and is to date the most

effective method to solve the shortage of kidney donors in a number of countries, including the Netherlands. Laparoscopic donor nephrectomy (LDN) has become the preferred method to procure kidneys in live donors because of the reduced surgical trauma and reduced pain subsequently, shorter convalescence time and superior quality of life as compared with open approaches [3–5]. However, safety issues of LDN has been debated. We recently showed that right-sided LDN is easier to perform as compared with left-sided LDN [7]. Although right-sided LDN is preferred in our center wherever the anatomical configurations of both kidneys are identical, aspects such as the presence of

multiple arteries on the right side demand left-sided nephrectomy in approximately 50% of the donors. At our center, we therefore introduced the hand-assisted retroperitoneoscopic approach (HARP) as an alternative for the left-sided LDN on the presumption that transplantation procedure as per this technique could be performed faster and the same would be at least as safe as the standard laparoscopic approach. In theory, HARP combines the control, dexterity and speed of the hand-guided surgery with the benefits of minimal invasive surgery, benefits of LDN including retroperitoneal access and reduced surgical trauma. Other smaller series have suggested certain advantages from the HARP technique over LDN such as shorter operation times and possibly fewer complications [8–10].

Based on these promising results of the HARP technique, we hypothesized that HARP might result in a better outcome in patients undergoing left-sided donor nephrectomy. Therefore, we evaluated the results of the first 20 left-sided HARP procedures alongside 40 left-sided LDNs performed during the same timeframe.

## Patients and methods

### Patient population

Between July 2006 and May 2008, 143 live kidney donors were operated at our center. The anatomy of the renal parenchyma and the arterial and venous anatomy of the kidneys were imaged by a combination of ultrasonography (US), and either magnetic resonance angiography (MRA) or computed tomography-angiography (CTA). Wherever the imaging studies revealed unilateral anatomical abnormalities i.e. ipsilateral arterial stenosis, that side was chosen. If multiple arteries (including early branching), veins or ureters were present unilaterally, the contralateral kidney was selected for removal. Eighty-three donors underwent right-sided LDN and were not included in the present analysis. The first 20 left-sided HARP operations were performed and compared with the procedures of 40 donors that underwent left-sided LDN during the same period. The reasons to opt for either type of operation were based on the anatomy, BMI, and previous abdominal operations. Discussions were held with all patients in a working group, wherein they were informed about the details of the various procedures and asked for consent. The Institutional Review Board of the Erasmus MC approved the study.

### Surgical techniques

Both procedures were performed with the donor placed in right decubitus position. LDN was performed as described earlier [11]. In short, a 10-mm trocar was introduced under direct vision. The abdomen was insufflated to 12 cm water column pressure of carbon dioxide.

A 30° video endoscope and three to four additional trocars were introduced. The colon was mobilized and displaced medially. Opening of the renal capsule and division of the perirenal fat were facilitated using an ultrasonic device (Ultracision, Ethicon, Cincinnati, OH, USA). After identification and careful dissection of the ureter, the renal artery and the renal vein, a Pfannenstiel incision was made. An endobag (Endocatch, US surgical, Norwalk, CT, USA) was introduced into the abdomen. The ureter was clipped distally and divided. The renal artery and vein were divided using an endoscopic stapler (EndoGIA, US Surgical, Norwalk, CT, USA) and the kidney was placed in the endobag and extracted through the Pfannenstiel incision.

In HARP procedure, we started with a 7- to 10-cm Pfannenstiel incision. After blunt dissection to create a retroperitoneal space, the Gelport (Applied Medical, Rancho Santa Margarita, CA, USA) was inserted. Blunt introduction of the first trocar between the iliac crest and the handport was guided by the operator's hand inside the abdomen. CO<sub>2</sub> was insufflated retroperitoneally to 12 cm water column pressure of carbon dioxide. Two other 10–12 mm trocars were inserted just outside the midline inferior to the costal margin and in the flank respectively, to create a triangular shape. For dissection the aforementioned UltraCision device was used. Dissection of the kidney and renal vessels was performed in procedure similar to transperitoneal donor nephrectomy but with hand-assistance and from a slightly different angle. The kidney was removed manually.

### Outcome

A research fellow prospectively recorded operation- and warm ischemia time, intra- and postoperative complications and blood loss during the procedure. In addition, the donor was examined daily after the donation by the research fellow and clinical parameters, including pain scores were noted. Intraoperative and postoperative complications were graded according to the modified Clavien grading system described by Kocak *et al.* [12]. Serum creatinine was recorded preoperatively, and postoperatively on days 1, 2, 3 (if still admitted) and approximately 3 weeks and annually thereafter. Glomerular filtration rate (eGFR) was estimated using the Modification of Diet in Renal Disease formula, which estimates GFR using four variables: serum creatinine, age, race, and gender [13]. Graft and recipient survival were recorded. Serum creatinine of the recipient was recorded preoperatively, during the first 14 days, day 21, 28 and every 3 months thereafter. The donor was discharged provided a normal diet was tolerated and mobilization was

adequate. Postoperative hospital stay was calculated with and without correction for time spent in hospital as a result of nonmedical reasons (i.e. lack of homecare). Postoperatively, visits to the outpatient clinic were scheduled at 3 weeks, one year and yearly thereafter.

### Statistical analysis

Categorical variables are presented as number (percentage). Continuous variables are presented as median (range). Categorical variables were compared with the chi-squared test. Continuous variables were compared with the Mann–Whitney *U*-test. All analyses were conducted using *SPSS* (version 15.0, SPSS Inc., Chicago, IL, USA). A *P*-value <0.05 (two-sided) was considered statistically significant.

## Results

### Baseline characteristics

Twenty donors underwent HARP and 40 donors underwent LDN. More female patients underwent HARP as compared with LDN (75% vs. 40%, *P* = 0.02). Other baseline characteristics did not differ between groups (Table 1).

### Intraoperative data

Median skin-to-skin time was shorter in the HARP group compared with the LDN group (180 min vs. 225 min, *P* = 0.002). Warm ischemia time was significantly shorter for the HARP group (3 min vs. 5 min, *P* = 0.007). Blood

**Table 1.** Baseline characteristics of donors who underwent hand-assisted retroperitoneoscopic donor nephrectomy (HARP) and laparoscopic donor nephrectomy (LDN) and the corresponding recipients.

	HARP ( <i>n</i> = 20)	LDN ( <i>n</i> = 40)	<i>P</i> -value
Gender: female (%)	75	40	0.02
BMI (kg/m <sup>2</sup> )	26 (19–32)	27 (20–36)	0.28
Age (years)	57 (36–72)	53 (30–71)	0.10
Solitary artery (%)	75	80	0.63
Solitary vein (%)	100	85	0.19
ASA-classification >1 (%)	35	25	0.42
Recipient			
Gender: female (%)	35	42	0.57
Age	53 (21–74)	51 (20–79)	0.79
Relation			
Living related (%)	40	45	0.91
Living unrelated (%)	35	30	
Cross-over (%)	25	25	
Pre-emptive (%)	45	30	0.16

Categorical data are presented as number (percentage). Continuous data are presented as median (range).

**Table 2.** Intraoperative data of hand-assisted retroperitoneoscopic (HARP) versus laparoscopic donor nephrectomy (LDN).

	HARP ( <i>n</i> = 20)	LDN ( <i>n</i> = 40)	<i>P</i> -value
Skin to skin time (min)	180 (115–370)	225 (130–410)	0.002
Warm ischemia time (min)	3 (2–9)	5 (1–23)	0.007
Conversion (%)	1 (5)	1 (2.5)	0.61
Blood loss (ml)	200	150	0.39
Complications (%)	2 (10)	10 (25)	0.17

HARP, hand-assisted retroperitoneoscopic; LDN, laparoscopic donor nephrectomy.

Categorical data are presented as number (percentage). Continuous data are presented as median (range).

loss was minimal, and did not significantly differ between groups. Intraoperative complication rates for HARP and LDN (respectively 10% vs. 25%, *P* = 0.17) did not significantly differ between groups (Table 2). Intraoperative complications graded according to the modified Clavien grading system are displayed in Table 3.

### Postoperative data

Postoperative complication rates for HARP and LDN (respectively 5% vs. 15%, *P* = 0.25) did not significantly differ between groups (Table 4). Postoperative complications in the laparoscopic group included three wound infections, incisional hernia of the infra-umbilical port 2 months after donation (Re-operation and primary closure), epidermolysis resulting from plasters, and temporary disorder in heart rhythm, which eventually needed monitoring without therapy. In the HARP group, one procedure was complicated by wound infection of the Pfannenstiel incision. In all recipients, urine production was noted before closure of the wound.

### Mid-term outcome

During a median follow-up of 18 months, estimated glomerular filtration rates in both donors and recipients did not differ (Figs 1 and 2). Graft- and recipient survival did not significantly differ between recipients who received a graft procured by HARP and LDN respectively (Table 4).

## Discussion

Live kidney donation is an important alternative for patients with end-stage renal failure and is to date the most effective way to solve the shortage of donor kidneys in a number of countries, including the Netherlands. We aim for perfection in operative technique for the healthy

**Table 3.** Intraoperative complications of hand-assisted retroperitoneoscopic (HARP) and laparoscopic donor nephrectomy (LDN) with grading by severity.

Grade*	Percentage of all complications (n = 2)	Percentage of total series (n = 20)	Complications	Patients (n)
<b>HARP</b>				
1	0	0	0	0
2	100 (n = 2)	10	0	2
2a	50 (n = 1)	5	Lumbar vein injury	1
2b	0	0	0	0
2c	50 (n = 1)	5	Lumbar vein injury, conversion	1
3	0	0	0	0
4	0	0	0	0
<b>LDN</b>				
1	50 (n = 5)	12.5	Blood loss <500 ml	5
2	50 (n = 5)	3.8	0	5
2a	10 (n = 1)	2.5	Blood loss >500 ml	1
2b	30 (n = 3)	7.5	Small bowel injury	1
			Bladder lesion	1
			Ureteral injury	1
2c	10 (n = 1)	2.5	No overview, conversion to hand-assisted LDN	1
3	0	0	0	0
4	0	0	0	0

HARP, hand-assisted retroperitoneoscopic; LDN, laparoscopic donor nephrectomy.

\*1, Non life-threatening complications.

2a, Complications requiring only use of drug therapy, blood loss >500 ml or Hb drop >2 g/dl and/or resulting in hemodynamic instability or Hb <8 g/dl, readmission to hospital for medical management or prolongation of hospital stay for more than three times median length of stay.

2b, Complications requiring additional therapeutic intervention (i.e. operation for bowel obstruction, interventional radiologic procedure) or readmission to the hospital for intervention.

2c, Complications requiring open conversion of LDN for patient management.

3, Any complication with residual or lasting functional disability.

4, Leads to renal failure or death in the donor.

population of live kidney donors. This study shows that HARP donor nephrectomy is associated with shorter operation and warm ischemia times and offers at least equal safety in a selected group of patients. These results indicate that HARP may be a valuable alternative for left-sided LDN at least in well-defined cases.

Hand-assisted retroperitoneoscopic donor nephrectomy seems to be associated with certain advantages

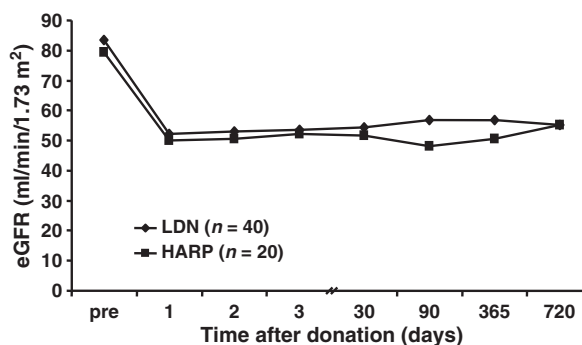
**Table 4.** Postoperative data of hand-assisted retroperitoneoscopic (HARP) versus laparoscopic donor nephrectomy (LDN).

	HARP (n = 20)	LDN (n = 40)	P-value
Complications (%)	1 (5)	6 (15)	0.25
Hospital stay (days)	3 (2–7)	4 (1–7)	0.19
Recipient survival* (%)	19 (95)	37 (93)	0.71
Graft survival (%)	17 (85)	36 (90)	0.44

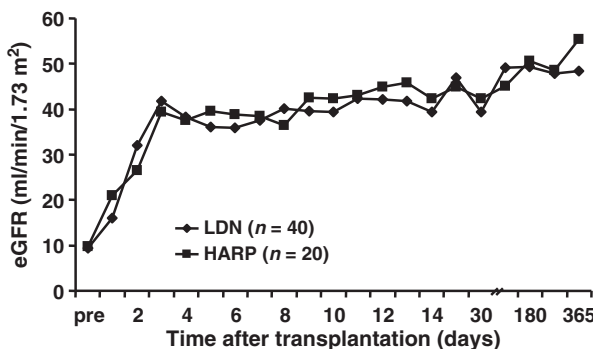
HARP, hand-assisted retroperitoneoscopic; LDN, laparoscopic donor nephrectomy.

\*All recipients died with functioning transplants.

Categorical data are presented as number (percentage). Continuous data are presented as median (range).



**Figure 1** Estimated glomerular filtration rate after live kidney donation (MDRD-formula).



**Figure 2** Estimated glomerular filtration rate after kidney transplantation (MDRD-formula).

over the laparoscopic transperitoneal approach including easier and rapid control of bleedings by digital pressure, better exposure and dissection of structures (in particular the upper pole of the kidney), less chance of injuring intra-abdominal organs, more control in the stapling phase and easy and fast removal of the kidney. The surgeon's tactile feedback may be advantageous for vascular control. Overall, these advantages may lead to

a shorter skin to skin- and warm ischemia time [8–10]. Part of the advantages is as a result of the hand-assistance, the remainder a result of the retroperitoneal access. Possible disadvantages include inferior ergonomics for the surgeon and possible higher pain scores through hand-manipulation. The possible association between pain and hand-assistance has only been described in one study comparing the laparoscopic and HARP technique. This study did not show a difference in pain scores and morphine requirement [9]. In the past, we successfully applied a mini-incision, retroperitoneal open approach with excellent results regarding safety. To determine the best approach for live donor nephrectomy to minimize discomfort to the donor, we performed a randomized controlled trial comparing mini-incision versus LDN. Laparoscopic donor nephrectomy results in a better quality of life compared with mini-incision open donor nephrectomy but equal safety and graft function [4]. We previously reported our data on left-sided versus right-sided LDN, with more intraoperative complications in the former group [7]. To improve our results, we searched for an alternative for left-sided donor nephrectomy. In the current approach, we try to combine the best of all techniques; retroperitoneal access, minimal invasiveness, a Pfannenstiel incision and manual control. Possible disadvantages of this approach concern tears in the peritoneum and postoperative pain resulting from continuous stretch of muscles and skin in the suprapubic region. Most tears occur where the peritoneum is firmly attached to the abdominal wall along the midline, the iliac crest, and the splenic corner. However, this does not have to be disadvantageous, and the operation could always proceed in the normal way.

Data on HARP donor nephrectomy are scarce. Our results are concordant with other nonrandomized cohort studies. Only two studies compare left-sided HARP with LDN [8,9]. Sundqvist *et al.* performed a prospective study, comparing HARP ( $n = 11$ ), LDN ( $n = 14$ ) and open donor nephrectomy ( $n = 11$ ). Hand-assisted retroperitoneoscopic donor nephrectomy had a significantly shorter operation time compared to LDN (145 min vs. 218 min,  $P < 0.05$ ). Gjertsen *et al.* performed a retrospective study, comparing HARP ( $n = 11$ ), LDN ( $n = 15$ ) and open donor nephrectomy ( $n = 25$ ). Reduced operation time was observed for the HARP group compared with the LDN (166 min vs. 244 min). Two centers posed the HARP approach as an alternative for right-sided donor nephrectomy [14,15]. Other centers published a retrospective comparison between retroperitoneoscopic donor nephrectomy and historical open controls [15,16].

Safety of the LDN is still debated, with most frequent complications of visceral and vascular lesions [17–20]. Many centers in Europe implemented the LDN, but there

are still a lot of centers where open donor nephrectomy is performed. Among the reasons to stick to the open donor nephrectomy are the learning curve and the issues of safety associated with the LDN. The aforementioned advantages with regard to the safety of HARP position HARP between mini-incision open and transperitoneal endoscopic approaches. Even in the learning curve, as these are the first 20 HARP-procedures at our center, we experienced excellent results, with minimal complications. This underlines our statement that minimally invasive techniques should be preferred over the open techniques; for those centers that did not adopt the LDN, HARP may become a feasible alternative [4–6].

Obviously, the design of this study has its drawbacks including the retrospective analysis. Probably some issue associated with selection of suitable donors for the HARP technique led to more females in the HARP group [21]. To address a potential statistically significant reduction of complications, the sample size of this study is clearly too small. Randomized controlled trials addressing safety, pain and quality of life of the donors are needed.

In conclusion, early results of the left-sided HARP technique are promising. Therefore, this technique is an interesting alternative to the transperitoneal laparoscopic approach.

## Authorship

LFCD, NFMK, JNMIJ designed study; LFCD, TT, TCKT, IPJA, JNMIJ performed study; LFCD, NFMK, WW, JNMIJ collected data; LFCD, NFMK analysed data; LFCD, NFMK, TT, TCKT, IPJA, WW, JNMIJ wrote the paper.

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