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Can right-sided hand-assisted retroperitoneoscopic donor nephrectomy be advocated above standard laparoscopic donor nephrectomy: a randomized pilot study

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Summary

Endoscopic techniques have contributed to early recovery and increased quality of life (QOL) of live kidney donors. However, laparoscopic donor nephrectomy (LDN) may have its limitations, and hand-assisted retroperitoneoscopic donor nephrectomy (HARP) has been introduced, mainly as a potentially safer alternative. In a randomized fashion, we explored the feasibility and potential benefits of HARP for right-sided donor nephrectomy in a referral center with longstanding expertise on the standard laparoscopic approach. Forty donors were randomly assigned to either LDN or HARP. Primary outcome was operating time, and secondary outcomes included QOL, complications, pain, morphine requirement, blood loss, warm ischemia time, and hospital stay. Follow-up time was 1 year. Skin-to-skin time did not significantly differ between both groups (162 vs. 158 min, $P = 0.98$). As compared to LDN, HARP resulted in a shorter warm ischemia time (2.8 vs. 3.9 min, $P < 0.001$) and increased blood loss (187 vs. 50 ml, $P < 0.001$). QOL, complication rate, pain, or hospital stay was not significantly different between the groups. Right-sided HARP is feasible but does not confer clear benefits over standard right-sided LDN yet. Further studies should explore the value of HARP in difficult cases such as the obese donor and the value of HARP for transplantation centers starting a live kidney donation program (Dutch Trial Register number: NTR3096). Nevertheless, HARP is a valuable addition to the surgical armamentarium in live donor surgery.

Introduction

Live kidney donation is increasingly accepted as the benefits for recipients are enormous and the risk of morbidity is low and mortality is rare [1]. Minimally invasive endoscopic techniques have contributed to early recovery and increased quality of life (QOL) of live kidney donors [2–4]. However, safety issues of laparoscopic donor nephrectomy (LDN) have been debated. In particular, major complications such as bleeding and visceral injury are more common in the laparoscopic era [5]. Hand-assisted retroperitoneoscopic donor nephrectomy (HARP) has been introduced as a potentially safer alternative, combining the advantages of manual control with the benefits of retroperitoneal access and minimally invasive surgery [6–9].

We previously reported data of a prospective database indicating a higher intraoperative complication rate for left-sided LDN as compared to right-sided LDN [10]. For this reason, we explored the benefits of left-sided HARP. In the first 20 procedures, the operation time was significantly reduced as compared to LDN. In this series, complication rates were lower but the difference did not reach a statistical significance [11]. We recently completed a randomized controlled trial in which left-sided HARP and LDN were compared [12]. HARP appeared beneficial in terms of intraoperative safety (no visceral injuries, no life-threatening

bleeds) and shorter operating times. In the current pilot study, we explored the feasibility and potential benefits of HARP for right-sided donor nephrectomy in a randomized fashion.

Materials and methods

Patients

All donors scheduled for right-sided donor nephrectomy at the Erasmus MC, University Medical Center in Rotterdam, the Netherlands, were eligible for inclusion in this study. All donors were discussed in a multidisciplinary working group. The anatomy of the renal parenchyma and vascular anatomy of the kidneys were visualized using a combination of ultrasound and magnetic resonance angiography or computed tomography angiography. If unilateral anatomical abnormalities, that is, ipsilateral arterial stenosis, were present, that kidney was retrieved. If a significant difference in function was expected between both kidneys, based on size, the smaller kidney was retrieved. Reasons to remove the contralateral kidney included the presence of multiple arteries (including early or retrocaval branching), veins, or ureters unilaterally. If no difference between the kidneys was assessed, a right-sided nephrectomy was scheduled, according to preference [10, 13]. If donors specifically asked for either a laparoscopic or a hand-assisted approach, they were not eligible for inclusion. Provided donors were 18 years or older and sufficiently understood the Dutch language, they were candidates for inclusion in this study. Eligible donors were informed on details of the study and procedures at our outpatient clinic by a transplant surgeon. They also received written information. Upon admission, the day before surgery, they provided written informed consent. The local medical ethics committee approved the study protocol, and the trial was registered in the Dutch Trial Register (number: NTR3096).

Anesthesia and Analgesia

Donors were prehydrated the day before surgery using intravenous crystalloids. Preoperative donors received 1000 mg acetaminophen and were fitted with antiembolic stockings during the operation. After endotracheal intubation, anesthetic procedures were performed according to a strict protocol for medication, ventilation, and fluid. Before clamping of the artery, 20 mg mannitol was administered intravenously. No antibiotic prophylaxis was given. At the end of operation, donors received patient-controlled analgesia (PCA). This device enables the donor to administer morphine or piritramide intravenously from a 50-cc syringe (1 mg/ml) by pressing a button. Furthermore, two 500 mg acetaminophen tablets were offered four times daily until discharge. If the PCA device had not been used during 6 h, it was removed. Nausea was treated with granisetron one milligram up to three times daily.

Surgical procedures

All procedures were performed in a high-volume live donor kidney transplantation center by five credentialed surgeons who were experienced in both procedures. The trial statistician provided a computer-generated randomization list with a block size of four. He provided opaque, sealed envelopes to the study coordinator. There was no stratification. When the donor was under general anesthesia, the research coordinator was called by telephone to open the envelope. After surgery, donors or their relatives were not informed on which donor nephrectomy technique was used. The incisions were similar for both techniques, and hence, donors were fully blinded regarding the performed procedure.

A research fellow was present during all procedures to document intraoperative data such as blood loss, operation time, and complications. Complications were defined as events requiring interventions or causing longer operating time or longer hospital admission. Skin-to-skin time was defined as the interval between incision and placement of the final suture. Warm ischemia time was defined as the interval between clamping of the first artery and the moment of flushing the kidney with UW fluid at the back table. Blood loss was measured by both weighing all blood-stained surgical gauzes and measuring all collected blood by the suction device.

Both techniques have been described for left-sided donor nephrectomy before [11]. For right-sided donor nephrectomy, donors were placed in left lateral decubitus position. During LDN, the camera and three to four additional trocars were introduced under vision. After identification and dissection of the kidney, ureter, and vascular structures, 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 subsequently divided using an endoscopic linear stapler (EndoGia, US Surgical). The kidney was placed in the endobag and extracted through the Pfannenstiel incision.

During HARP, the Pfannenstiel incision was the first step. Using blunt dissection, a retroperitoneal space was created and a Gelport (Applied Medical, Rancho Santa Margarita, CA, USA) was inserted. Blunt introduction of the first trocar between the iliac crest and the Gelport was guided by the operating surgeon's hand inside the abdomen. The additional trocars were placed under direct vision. Dissection of the kidney, ureter, and vascular structures was similar to LDN, but with hand assistance and from a slightly different angle. The kidney was extracted manually.

In both procedures, the abdominal muscles and subcutaneous fascia were approximated. Skin wounds were sutured intracutaneously.

Recipients

Recipients and donors were allocated to different surgical wards, to minimize the influence on donor recovery. All renal grafts were placed preperitoneally in the iliac fossa. Recipients received a calcineurin inhibitor-based immunosuppressive regimen to avoid rejection. Recipient and graft survival were recorded up to 1 year, as well as estimated serum glomerular filtration rates (eGFR) pre- and postoperatively.

Data collection

The aforementioned research fellow recorded all pre-, intra-, and postoperative data. Donors visited the outpatient clinic approximately 1 month after discharge. Intraoperative and postoperative complications were graded according to the modified Clavien grading system, described by Kocak *et al.* [14]. Donor eGFR was computed according to the four-variable modification of diet in renal disease (MDRD) formula preoperatively and postoperatively at days 1, 2, 3 (if the donor was still admitted) and 1 month and 1 year after surgery, at the first visit to the outpatient clinic. The donor was discharged from the hospital if a normal diet was tolerated and adequate mobilization was achieved.

In order to assess the effect of both surgical techniques on physical and psychosocial health, donors were asked to complete forms quantifying quality of life, pain, using validated questionnaires. The Short Form-36 (SF-36) was administered preoperatively and at 1 month and 1 year postoperatively. The SF-36 is a multi-item scale that measures eight health dimensions: physical function, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and mental health. Scores for each of these health concepts range from 0 to 100, with higher scores indicating better QOL.

Pain and nausea were assessed using a visual analogue scale (VAS) questionnaire during admission preoperatively and at days 1 and 2. Out of hospital they filled out forms at days 7 and 14. Donors had to choose a point on a 10-cm line (range from 0 or no pain to 10 or severe pain), which best corresponded with the experienced pain and nausea.

Statistical considerations

Although we designed the current study to explore potential benefits, we have chosen a randomized concept in order to obtain comparable groups, thereby avoiding selection bias. With a low intraoperative complication rate for right-sided laparoscopic donor nephrectomy, it would be unlikely to find any further reduction in intraoperative events [10]. Serious adverse events including life-threatening bleeding and visceral injuries, or re-interventions, are so rare in the current era of live donor nephrectomy that thousands of donors would have to be included in a randomized trial to demonstrate either a difference or similarity. The other potential measurable parameter that might have been influenced by HARP was operation time. We therefore chose skin-to-skin time as primary outcome. A difference of half an hour between the HARP and LDN group was considered to be clinically relevant. With an alpha of 0.05 and a beta of 0.20, we calculated that we had to randomize 20 donors in either group. However, 20 donors in either group would give an indication of the effect of HARP on operation times, complications, blood loss, pain, nausea, and QOL to direct further studies. These outcomes were prespecified as secondary outcomes.

We attempted to incorporate all minor complications by attendance of a research fellow in the operation room and daily on the surgical ward. This strategy has led to relatively high rates of intraoperative complication rate in our previous studies. However, one should recognize that all minor events are scored, even those events that would not severely affect the intra- and postoperative course. These minor events are by definition underscored in all retrospective studies. Categorical variables were compared using chi-square test. Continuous variables were compared using Mann–Whitney *U*-test. Differences with regard to QOL dimensions were calculated with and without adjustment for baseline levels, gender, and age. Analyses were conducted using SPSS (version 20.0, SPSS Inc., Chicago, IL, USA). Data were analyzed according to the intention-to-treat principle. A P-value <0.05 (two-sided) was considered statistically significant.

Results

Between April 2011 and January 2012, 40 live kidney donors were randomized. Baseline characteristics are shown in Table 1. Sixty-one donors were not eligible for inclusion (Fig. 1). Fifty-seven of these donors underwent left-sided donor nephrectomy. Four donors underwent right-sided donor nephrectomy, but were not included in the study: one donor whose command of the Dutch language was insufficient, one donor who did not wish to participate, one donor whose operation was specifically scheduled for LDN for educational purposes, and one donor who had a neurostimulator on the right side precluding HARP. We evaluated the primary endpoint in 40

Table 1. Baseline characteristics. Categorical data are given as No. (%) and continuous variables as median (range).

	HARP (n = 20)	LDN (n = 20)
Donor		
Female	8 (40%)	15 (75%)
Body Mass Index – kg/m^2	24.7 (19.8–34.1)	24.0 (18.5–32.5)
Age – years	47 (21–77)	49 (22–73)
American Society of Anesthesiologists >1	9 (45%)	8 (40%)
Arteries >1	3 (15%)	3 (15%)
Veins >1	4 (20%)	2 (10%)
eGFR – ml/min/1.73 m^2	88 (59–114)	84 (63–126)
SF-36 donor*		
Physical function	98.5 (3.7)	93.6 (12.3)
Role physical	93.8 (19.7)	90.0 (27.4)
Bodily pain	97.1 (13.2)	91.6 (15.7)
General health	86.7 (12.7)	86.9 (10.6)
Vitality	78.7 (11.3)	79.5 (13.3)
Social functioning	98.1 (6.1)	93.1 (14.3)
Role emotional	91.7 (26.2)	95.0 (16.3)
Mental health	69.3 (10.2)	69.5 (8.4)
Recipient		
Female	10 (50%)	7 (35%)
Age – years	50 (2–74)	54 (22–75)
Pre-emptive	9 (45%)	7 (35%)
eGFR – ml/min/1.73 m^2	9 (5–24)	9 (3–21)

*Data provided as mean (SD).

donors (100%) and QOL in 34 donors (85%) at 1 month and in 25 donors (63%) at 1 year.

Intraoperative outcomes

Median skin-to-skin time, the time between first incision and placement of the last skin suture, did not differ significantly between both groups (Table 2). Median warm ischemia time was statistically significantly shorter in the HARP group. However, increased blood loss was observed. The HARP group required a statistically significantly larger Pfannenstiel incision. Conversions were not necessary.

The intraoperative complication in the LDN group concerned an iatrogenic laceration of the bladder (grade 2b). Intraoperative complications in the HARP group included the loss of a surgical gauze during the procedure requiring fluoroscopy (grade 1) and a hemorrhage of more than 500 ml (grade 2a). One graft-related complication occurred in the HARP group, a laceration of the kidney capsule.

Postoperative outcomes

The postoperative course was uncomplicated in 34 donors (85%; Table 2). No significant differences were observed with regard to postoperative complication rate, reoperations, readmissions, hospital stay, and total morphine or piritramide requirement. In the LDN group, one donor underwent exploratory relaparoscopy for a suspected hemorrhage. Because no hemorrhage was found intraperitoneally, the Pfannenstiel incision was re-opened, exposing a preperitoneal hemorrhage. The donor was discharged 4 days after surgery.

Postoperative complications led to two readmissions in the HARP group. One donor was readmitted to treat a retroperitoneal abscess by percutaneous drainage and antibiotics (grade 2b), and the other donor was readmitted because of obstipation and was treated with laxatives (grade 2a). The other complication concerned a urinary tract infection requiring antibiotics (grade 1). In the LDN group, postoperative complications included a urethral laceration during removal of the catheter (grade 1), a pneumonia

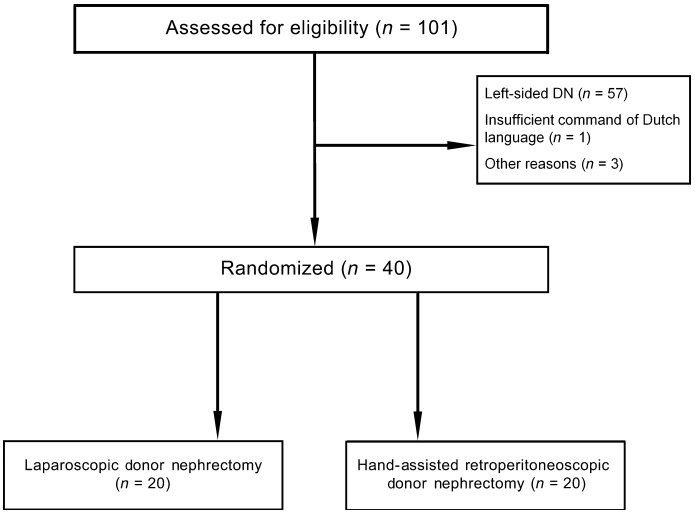

Figure 1 Trial flowchart.

Table 2. Intraoperative and postoperative outcomes of donor and recipient. Categorical data are given as No. (%) and continuous variables as median (range).

	HARP (n = 20)	LDN (n = 20)	P-value
Intraoperative			
Skin-to-skin time (min)	162 (98–205)	158 (97–296)	0.98
Warm ischemia time (min)	2.8 (2–5)	3.9 (3–5)	<0.001
Blood loss (ml)	187 (25–500)	50 (0–260)	<0.001
Incision Pfannenstiel (cm)	10.0 (7.5–14.0)	8.5 (6.4–11.5)	0.016
Complications*	2 (10%)	1 (5%)	0.55
Grade 1	1 (5%)	0	
Grade 2a	1 (5%)	0	
Grade 2b	0	1 (5%)	
Graft-related complications	1 (5%)	0	0.31
Postoperative			
Complications*	3 (15%)	3 (15%)	1.00
Grade 1	1 (5%)	2 (10%)	
Grade 2a	1 (5%)	0	
Grade 2b	1 (5%)	1 (5%)	
Postoperative hospital stay – days	3 (2–4)	3 (1–6)	0.83
Readmissions	2 (10%)	0	0.15
Reoperations	0	1 (5%)	0.31
Morphine requirement – mg	9 (0–50)	16 (0–94)	0.58
Donor eGFR – ml/min/1.73 m^2			
Day 1	53 (38–67)	50 (34–82)	0.58
Month 1	54 (33–62)	55 (37–76)	0.59
Year 1	54 (34–79)	59 (38–86)	0.48
Recipient eGFR – ml/min/1.73 m^2			
Day 1	21 (8–61)	22 (5–38)	0.67
Month 1	48 (9–88)	51 (21–80)	0.61
Year 1	46 (18–90)	44 (15–78)	0.91
One-year recipient survival	18 (90%)	20 (100%)	0.16
One-year graft survival	19 (95%)	20 (100%)	0.31
Pain – VAS 0–10			
Day 1	2.8 (0–6.8)	3.1 (0–5.5)	0.95
Day 2	1.7 (0–4.9)	1.5 (0–7.5)	0.77
Day 3	1.4 (0–5.3)	2.1 (0–5.8)	0.50
Day 7	1.0 (0–4.9)	1.2 (0–5.4)	1.00
Day 14	0.8 (0–4.8)	0.5 (0–7.5)	0.88

*Graded according to the adapted Clavien-Dindo scoring system.

requiring antibiotics (grade 1), and the hemorrhage described above (grade 2b).

At 1-year follow-up, serum eGFR levels for donors and corresponding recipients and recipient survival did not differ between the groups. One graft in the HARP group was lost, and this was due to technical problems during implantation. Re-implantation resulted in an extended warm ischemia time and hence in primary nonfunction and graft loss. However, no significant difference was observed between the groups regarding graft survival. Two donors in the HARP group deceased during follow-up, one due to a gastric carcinoma and another due to cardiac problems. Pain scores did not significantly differ between both groups at any point in time. The median nausea score was 0 for both groups at any point in time; no significant difference between both groups was observed.

Quality of life

During 1-month follow-up, six donors indicated that they did not wish to participate in the study anymore, three in either group. For this reason, at that moment, quality of life was analyzed in 34 donors in total. There were no significant differences between the groups regarding the quality of life dimensions at 1-month follow-up. During 1-year follow-up, two donors emigrated and were unavailable for follow-up. In addition, seven donors indicated that they no longer wished to participate in the study. At 1-year follow-up, quality of life was analyzed in a total of 25 donors. After adjustment for age, gender, and baseline values, we did not assess any significant differences during follow-up (Table 3).

Discussion

The safety of the graft after right-sided laparoscopic donor nephrectomy has long been debated. After an initial alarming report by Mandal *et al.* [15], who described post-transplant renal vein thrombosis in three of eight grafts, we and others proved right-sided LDN to be safe [10,13,16]. Moreover, right-sided LDN was easier to learn in our view. Favorable complication rates and shorter operation times as compared to left-sided LDN have directed our decision to retrieve the right kidney in case of identical anatomy between the two kidneys. We have always explained the benefits of right-sided donor nephrectomy by the frequent absence of side branches of the renal vein, the adjacent liver, which is easier to retract than the spleen, the hepatic colonic flexure, which is often easier mobilized than the splenic flexure, and the more caudal position of the kidney. In our experience, length of the right renal vein is never a contraindication for right donor nephrectomy. Adequate positioning of the donor and stapling as close to the inferior caval vein as possible will aid in procuring sufficient length. A short renal vein after right-sided donor nephrectomy has never impeded implantation. However, transplant surgeons should adhere to the principle to leave the best kidney to the donor. There is an indication to remove the left kidney in more than half of the donors [10].

In contrast to the literature, we previously reported a 19% intraoperative complication rate for left-sided LDN.

Table 3. Quality of life during follow-up, corrected for gender, age, and baseline value. Data are given as mean (SD).

	One month			One year		
	HARP (n = 17)	LDN (n = 17)	P-value	HARP (n = 11)	LDN (n = 14)	P-value
Physical function	67.8 (20.9)	67.1 (19.9)	0.99	93.8 (10.3)	88.6 (26.6)	0.22
Role physical	32.4 (36.2)	30.7 (37.6)	0.96	89.6 (29.1)	80.4 (39.4)	0.63
Bodily pain	73.2 (16.2)	71.9 (18.7)	0.78	90.2 (15.5)	84.1 (27.4)	0.50
General health	81.6 (16.4)	76.1 (13.2)	0.49	79.5 (20.7)	78.1 (21.8)	0.95
Vitality	64.7 (20.0)	58.8 (18.6)	0.51	72.7 (20.8)	74.8 (15.8)	0.59
Social functioning	76.5 (21.6)	77.2 (23.9)	0.49	90.6 (18.6)	92.0 (16.0	0.46
Role emotional	78.4 (40.7)	66.7 (45.4)	0.38	83.3 (38.9)	97.6 (8.9)	0.16
Mental health	65.5 (13.2)	60.9 (10.5)	0.26	63.6 (16.6)	63.0 (17.5)	0.90

This included primarily minor complications without consequences for the postoperative tract but also complications that could have had major consequences. Although we did think that many retrospective reports in the literature underestimated the true complication rate, our prospective data demanded a novel approach for left-sided kidney donation. Therefore, we explored HARP for left-sided donor nephrectomy with stunning early results [11]. In the first twenty procedures, the operation times were significantly lower and the complication rate was lower, albeit not statistically significant due to a small sample size. In a recently conducted randomized controlled trial, we confirmed the inferences of the pilot study. These included shorter operation time and warm ischemia time, the absence of major bleeds, visceral injury and exceptional long warm ischemia times, despite a long tradition of laparoscopic donor nephrectomy at our center, and a relatively short experience with HARP [12].

Although our results for right-sided LDN were significantly better, we decided to explore the potential benefits for right-sided HARP in the current study. The results of this pilot study show that right-sided HARP is feasible. Furthermore, life-threatening bleeds and visceral injuries did not occur in the HARP group. The relatively high intraoperative complication rate is a result of the small sample size and an uncommon complication as a gauze that was lost. On the other hand, an intra-abdominal abscess that has to be drained is an uncommon postoperative complication after standard LDN. The intra- and postoperative complication rates for right-sided LDN were comparable to previous reports [10]. No incisional hernias were observed, which is concordant with previously published research [17]. For right-sided donor nephrectomy, we did not observe a significant reduction in operation time using the hand-assisted retroperitoneoscopic technique. Warm ischemia times in this study were comparable to previous studies in our centre and other reports in the literature [11,12,18,19]. Warm ischemia time was significantly shorter in the HARP group. The clinical relevance of this difference remains to be demonstrated as there are no reports on small differences in warm ischemia time and graft-related outcome in current literature. Nevertheless, warm ischemia times should be kept as short as possible. As may be expected when both techniques have the similar scars and operation time, hospital stay and QOL did not differ between the techniques.

Intraoperative blood loss was significantly higher in the HARP group when compared to the LDN group, 187 vs. 50 ml, respectively. This may be explained by the more extensive mobilization of tissue during blunt dissection of the retroperitoneum, leading to an increased blood loss. We do not judge this difference to be clinically relevant. In both groups, all intraoperative complications were grade 1 or 2, for example non-life-threatening or not leaving residual disability. Again, all complications have been recorded adequately. Therewith, we also included all adverse events with limited consequences for the postoperative course of the donor. To adequately assess a difference in safety, expressed by the complication rate between these techniques, a future study with complications as primary endpoint would be necessary. It seems unlikely that HARP will further reduce the low rate of complications for right-sided donor nephrectomy. Given the (historical) marginal difference in complication rates between these two techniques, such a future study would require a huge sample size. However, major vascular injuries may be dealt with quickly. Therefore, this technique likely reduces the risk of life-threatening bleeds.

During right-sided HARP, presence of a large liver impedes adequate access to the upper pole of the kidney. Dissection of the upper pole in these cases was complex, requiring increased manipulation of the kidney, sometimes leading to iatrogenic peritoneal damage. In these cases, the sudden emergence of a pneumoperitoneum often resulted in a decrease in retroperitoneal space and hence in a decreased surgical working space.

In live donor surgery, safety and quality of life are the most important factors when assessing the differences

between two surgical approaches. This pilot study was not designed and underpowered to reliably address the differences in these outcomes. However, the small differences observed in this randomized single-blind study are indicative of limited clinical differences. Bargmann *et al.* previously investigated the addition of hand assistance to transperitoneal laparoscopic donor nephrectomy in a similar designed study [20]. They did not show a beneficial nor a detrimental effect of hand assistance. We rather explored the retroperitoneoscopic approach as this approach technically avoids lesions to intraperitoneal organs.

The question may arise whether HARP may be helpful and if so, in which donors. In this study, age, obesity, and previous surgery did not preclude participation. HARP may be helpful in obese donors or donors suspected of having a fixed upper pole of the kidney, which we often experience in horse riders, motor cyclists, and boxers. In these cases, HARP may enable more traction. Furthermore, we would like to emphasize that all surgeons were very experienced in both techniques. Currently, more than 150 live donor nephrectomies are performed at our center annually, which is the highest volume of live donor nephrectomies in Europe. Potential positive effects of HARP on operation time and complication rate may have been blurred partially by abundant experience in the control arm. HARP may be beneficial for surgeons starting with endoscopic donor nephrectomy [21]. HARP may be instrumental to safely negotiate the learning curve of endoscopic techniques. Future studies should be directed at HARP in the aforementioned groups and learning curve effects. In order to maintain the highest standard of care for these healthy individuals, we advocate a donor-oriented decision model when selecting a surgical technique. More prospective, comparative studies on all surgical techniques used for live donor nephrectomy are required to be able to implement such a model [22].

In our opinion, right-sided HARP is a valuable addition to the surgical armamentarium in live donor surgery. In addition to others, we demonstrated that this technique is very safe and appears to have similar results as compared to standard LDN. Although HARP did not confer clear benefits over standard right-sided LDN in this randomized pilot study yet, we suggest that this technique has a place in live donor surgery and currently apply right-sided HARP in complex donors such as obese donors and donors with previous intra-abdominal surgery. The role of right-sided HARP in centers or surgeons at the beginning of their learning curve should be explored. Continental registrations may more likely than randomized controlled trials aid to resolve issues on safety of either technique. In order to maintain the highest standard of care for these healthy individuals, we advocate a donor-oriented decision model when selecting a surgical technique.

Authorship

KWJK, FJMFD, and NFMK participated in the writing of the paper, participated in data collection, and participated in data analysis. LFCD, WW, and JNMI participated in research design and participated in writing of the paper. TCKT and TT participated in data collection.

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