Laterality in laparoscopic hand assisted donor nephrectomy - Does it matter anymore? Outcomes of a large retrospective series

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ABSTRACT

This retrospective study was performed to analyse if laterality of the retrieved living donor kidney had any effect on donor and recipient outcomes after hand assisted laparoscopic donor nephrectomy (HALDN). 739 donors who underwent HALDN between January 2006 and January 2018 at a large tertiary transplant centre in the United Kingdom were included. Donor outcomes in individuals undergoing right versus left HALDN were compared with respect to conversion rates, morbidity, warm and cold ischaemia times and recipient failure rates, vascular and ureteric complications.

604 (81.7%) underwent left HALDN and 135 (18.3%) underwent right HALDN, mean age was 47.1 years and 46.8 years respectively with comparable gender distribution. The operative time was shorter for the left side ($p = 0.003$) and improved during the study for the left but not the right side. In recipients who received left kidneys there were more early technical failures observed (8 versus 1) though not statistically significant.

Most centres prefer performing a left nephrectomy and recipient surgeons prefer a left kidney for transplantation primarily because of having a longer vein. This large study provides reassurance that right HALDN nephrectomy is a safe procedure with similar outcomes to left HALDN.

Abbreviations: ESRD, End stage renal disease; HALDN, Hand assisted laparoscopic donor nephrectomy; QOL, Quality of life; CIT, Cold ischaemia time; WIT, Warm ischaemia time; HARPDN, Hand assisted retroperitoneal donor nephrectomy; HTA, Human Tissue Authority; NHSBT, National Health Services Blood and transplant; FBC, Full blood count; CNI, Calcineurin Inhibitors; PNF, Primary non function; SD, Standard deviation; TRAS, Transplant renal artery stenosis.

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Introduction

Kidney transplantation remains the only renal replacement modality that delivers long term treatment for end stage renal disease (ESRD). Successful transplantation removes the need for dialysis, it increases longevity and leads to an improved quality of life (QOL).[1,2] Dialysis is associated with morbidity and increased mortality and detrimentally impacts patients' quality of life.[3,4] Along with psychological effects it also has financial implications for health care delivery.[2] There are currently over 5000 patients on the kidney transplant waiting list in the United Kingdom (UK) with the median waiting time for a kidney transplant just short of three years.

Living donor kidney transplantation

The first laparoscopic live donor nephrectomy was performed by Drs. Kavoussi and Ratner in 1995.[5] Hand assisted laparoscopic donor nephrectomy (HALDN) was introduced by Wolf et al., in 1998 due to concerns pertaining to the donor and prolonged warm ischaemia time (WIT) using the totally laparoscopic technique.[6–9] Of the minimally invasive techniques, HALDN/hand assisted retroperitoneal donor nephrectomy (HARPDN) offers tactile and haptic feedback with the added ability and advantage to digitally retract tissues. It has been shown to have a reduced WIT.[9,10] Important benefits of laparoscopic donor nephrectomy for the donor, compared to open nephrectomy are less pain, earlier return to normal daily routine, and improved cosmetic results.[2,5,9]

Left versus right donor nephrectomy

The left kidney is preferred by both recipient surgeons and donor surgeons. The rationale underlying this preference is the greater length of the left renal vein, making implantation technically easier in most cases.[1,3,11] There are however donor surgeons who prefer the right kidney due to the ease of retrieval since there are no adrenal or gonadal veins draining into the right renal vein.[5] From the anatomical perspective, a left donor nephrectomy predisposes the patient to splenic trauma which may require a splenectomy (a very rare event) and potential trauma to the tail of pancreas.[8,11] Early studies reiterated the safety of laparoscopic procurement of the right kidney.[1] There have been studies in recent years which have compared the risks and benefits of procuring either kidney however no single study has shown categorically a superiority of one side versus the other.[1,3,6,8,11]

Aims and objectives

The aim of this study was to retrospectively analyse donor and recipient outcomes in hand assisted laparoscopic donor nephrectomies performed at a large tertiary transplant centre in the United Kingdom. The specific objectives were to compare the donor and recipient outcomes in individuals undergoing right HALDN versus left HALDN with respect to 1) conversion rates 2) morbidity including ureteric complications 3) warm and cold ischaemia times in donated grafts and 4) graft function in recipients.

Materials and methods

Study design

This is a retrospective observational cohort study and was performed according to the principles underpinning the *Strengthening the reporting of observational studies in epidemiology* (STROBE) statement. As it was a retrospective anonymised review of outcomes, the Institutional Review Board did not require a Research Ethics Board review for the study.

Inclusion and exclusion criteria

All donors who underwent hand assisted laparoscopic donor nephrectomy and had complete data between January 2006 to January 2018 at the Manchester Royal Infirmary (MRI) were included. They consisted of related and unrelated donors, altruistic kidney donors and donors in the national paired exchange scheme. Eleven donors who underwent totally laparoscopic (transperitoneal or retroperitoneal) nephrectomy were excluded from this analysis. Additionally, 45 donors who underwent open donor nephrectomy during the study period were excluded. The 45 open cases were performed by two senior consultants, while the laparoscopic hand assisted technique was being established in the department. The open technique was offered as per patient preference. Once the laparoscopic technique was taken up and proven to be safe, open donor nephrectomy was discontinued.

In common with other new techniques, the right HALDN was introduced in a professional and accountable manner. The more experienced surgeons initially performed them and trained, less experienced surgeons subsequently. In the first six years only 16% of the right HALDN were performed by less experienced surgeons compared to 41% over the next six years.

Recipients and donors who had missing data were excluded from the analysis. The missing data was mainly; omitted operative times, warm and cold ischaemia times and/or laterality. The procedure was performed by nine different transplant surgeons.

Data access

Data were accessed and interrogated from the transplant database maintained by the renal and pancreas transplant unit at the study centre. Variables whose values were missing were interrogated from paper patient records or the Electronic Patient Record (EPR). Data was anonymised with the use of an independent unique identifier and stored on a secure NHS trust server.

Follow up

Follow up was up to 12 years. Follow-up details were accessed via patients' outpatient clinic notes and blood values via the EPR system. If the patient was readmitted for any reason, the discharge letter and inpatient notes were reviewed for that episode. At routine follow-up all donors

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had a full blood count (FBC), renal function tests, calcium and phosphate measured in addition to blood pressure and a general examination with specific focus on surgical incisions. All donors were followed up as per guidance from the Human Tissue Authority (HTA) and NHS Blood and transplant (NHSBT). All donors are reviewed annually to identify any health issues which may have potential consequences both for the donor and recipient. Other than these routine reviews, donors are encouraged to get in touch with the donor team, in case of any specific health issues which arise both related and unrelated to the donation. All details are submitted to NHSBT who maintain a national donor register.

Surgical technical considerations

The HALDN on either side was performed according to standard technique.

In all cases, standard laparoscopy is performed, and the abdomen is insufflated with CO2 to a pressure of 12 mm Hg. General laparoscopy ensuring no undiagnosed co-existent pathology is performed. The technique is identical to total laparoscopic transperitoneal nephrectomy except that in the hand-assisted technique, the operator's non-dominant hand, introduced via a Gelport ™, is utilised to maximum advantage.

For left HALDN, the hand, introduced via a supra-umbilical incision, is used to retract the splenic flexure of the colon and the spleen during dissection with the energy device. Once the splenic flexure and the spleen are mobilised, the intra-abdominal hand is positioned so that there is a working space within the palm and fingers in which dissection can be safely carried out, at the same time digitally identifying the kidney and its hilum and assisting in the dissection. Tactile feedback is greatly advantageous in helping delineate planes especially at the hilum.

On the right side, the hand is inserted via an infra-umbilical incision and an extra port is added for the liver retractor. Here particular attention is needed due to the proximity of the inferior vena cava.

The HALDN method facilitates retraction of the kidney for complete dissection from surrounding structures, providing tactile benefit over a purely laparoscopic approach and quicker vascular control.

Variables compared

- Donor outcomes analysed included conversion to open nephrectomy, significant haemorrhage requiring transfusion, warm ischaemia time (WIT), surgical re-explorations, surgical site infections, length of hospital stay and development of incisional hernia.
- Recipient outcomes analysed were cold ischaemia time (CIT), delayed graft function, primary non-function (PNF), haemorrhage, graft thrombosis, surgical re-explorations, transplant renal artery stenosis (TRAS), ureteric complications, graft failure and death with a functioning graft.
- An analysis of national practice was obtained from anonymised data provided by NHSBT. A comparison of preferences in laterality was thereafter made from this data.

Statistical analyses

Data were collected with MS Excel as continuous and categorical variables. Chi–Square tests were used to compare categorical variables, independent t-tests for parametric continuous variables and Mann–Whitney tests for non-parametric continuous variables. The results were considered statistically significant at $p < 0.05$. Statistical analyses were performed using R for Windows version 4.0.2, 2020 (The R Foundation for Statistical Computing).

Results

Donor characteristics and outcomes (Tables 1 and 3)

Whilst 860 HALDN procedures were carried out during the study period, 739 donors met the study criteria and were included in the analysis. 121 donors were excluded due to non-availability of data including warm and cold ischaemia times and duration of surgery. Of the analysis group 604 (81.7%) underwent a left HALDN and 135 (18.3%) underwent right HALDN. There were 276 (45.7%) male donors and 328 (54.3%) female donors in the left HALDN group whilst in the right sided HALDN group there were 67 (49.6%) males and 68 (50.4%) females. The mean age was 47.1 years and 46.8 years respectively (SD ± 12.5). This mirrored national practice, with 84% of laparoscopic donor nephrectomies performed being left and 16% being right.

The right kidney was preferred over the left due to favourable arterial anatomy in 60 (44%) donors, a poorer split isotopic GFR in 55 (41%) and various other reasons e.g., scarring and cysts in 20 (15%) donors. The mean surgical time was 167 min (SD ± 58.8) for the left HALDN and 182 min (SD ± 49.8) for the right HALDN ($p = 0.003$). The mean surgical time, from the first 6 years to the second 6 years of this period, reduced from 172 to 163 min ($p = 0.01$) for the left HALDN whereas it remained the same at 182 min for right HALDN. Warm ischaemia time in both groups was 3.5 min, left (SD ± 1.9) and right (SD ± 1.6) ($p = 0.67$). Mean cold ischaemia time was 196 min (SD ± 72.5) minutes for left kidney implants and 224 min (SD ± 83) ($p = 0.004$) for right kidney implants.

Of the nine cases that required conversion to open nephrectomy, 6 (0.9%) were left sided and 3 (2.2%) were right sided ($p = 0.45$). In the right HALDN group the reasons for conversion were a high retro-hepatic kidney, failure of the vascular stapling device and a haemorrhage from a lower

Table 1 – Donor demographic details.

Donor demographics			
	Left	Right	p value
Number of cases (n, %)	604 (81.70%)	135 (18.30%)	0.24
Average age (years)	47.1 (SD 12.5)	46.8 (SD 11.5)	0.45
Male (n, %)	276 (45.70%)	67 (49.60%)	0.46
Female (n, %)	328 (54.30%)	68 (50.40%)	
Average BMI (kg/m^2)	26.8 (SD 4.2)	27.6 (SD 4.2)	0.15
National UK Total	10,271 (84%)	2036 (16%)	0.24

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Table 2 – Recipient demographic details.

Recipient demographics	Left kidney recipients	Right kidney recipients	p value
Recipients (Adults) (n, %)	499 (81.40%)	114 (18.60%)	0.61
Male (n, %)	301 (60.30%)	67 (58.70%)	0.84
Female (n, %)	198 (39.70%)	47 (41.20%)	
Age (Mean in years)	41.9	45	0.96
Recipients (Paediatric)	105 (83.30%)	21 (16.70%)	0.61
Male (n, %)	61 (58.00%)	14 (66.60%)	0.62
Female (n, %)	44 (42.00%)	7 (33.30%)	

polar artery. In the left HALDN group one conversion was to locate a missing laparoscopic swab, and two due to haemorrhage from laparoscopic stapler failure, one due to renal vein haemorrhage and two due to haemorrhage from lumbar veins. Among the left HALDN group who had conversions two donors required further re-exploration for bleeding. Haemorrhage requiring transfusion intra-operatively occurred in six (0.9%) donors undergoing left HALDN whereas there was no transfusion requirement in right sided donors. There was no post-operative need for transfusions in both groups.

Donor re-explorations were performed in 13 (2.2%) of the left group and two (1.48%) of the right group donors ($p = 0.87$) (Table 3).

There was no difference in the technical complications between the surgeons involved.

Hospital acquired pneumonia occurred in 37 (6.12%) left HALDN donors and 3 (2.22%) right HALDN donors ($p = 0.11$). Urinary tract infections occurred in 22 (3.6%) versus 2 (1.48%) left and right HALDN donors respectively ($p = 0.31$). Surgical site infections were seen in 19 (3.14%) donors who had a left HALDN and 6 (4.44%) patients who had a right HALDN ($p = 0.62$). Length of hospital stay was equal in both groups with a median stay of 4 days [(range 2–61), ($p = 0.6$)] (Fig. 2). Donor incisional hernias subsequently treated with hernia mesh repair were found on follow-up in 36 (5.9%) of left HALDN donors and 7 (5.2%) of right HALDN donors ($p = 0.36$). Median time to detection of incisional hernia was 12 months (range 5–16 months). Two patients (0.33%) who had left HALDN developed pulmonary embolisms and were successfully treated. Data on testicular pain and chyle leak was not available and was not included.

The 28-day readmission rate in donors was 1.48% in the right group and 1.9% in the left group ($p = 0.9$).

Recipient characteristics and outcomes (Tables 2, 4 and 5)

The 739 donor kidneys were transplanted into 613 adult and 126 paediatric recipients with 499 adults receiving a left kidney and 114 receiving a right kidney. Among the paediatric recipients the distribution was 105 left kidneys and 21 right kidneys. PNF was observed in 1 recipient of a left kidney. Graft thrombosis occurred in 7 (1.2%) cases, one recipient developed a renal arteriovenous fistula, and another had acute limb ischaemia post-transplant requiring a femoral–femoral crossover graft. All these events were in recipients with implants from left HALDN kidneys (Fig. 1). Transplant renal artery stenosis (TRAS) was observed in 3 recipients in the left group. Perioperative haemorrhage was encountered in 5 (0.80%) recipients who received left kidneys and 2 (1.48%) ($p = 0.23$) who received the right. Re-explorations had to be carried out in 11 (2%) left kidney recipients and 2 (1.40%) right kidney recipients ($p = 0.92$). Among recipients who developed ureteric stenosis, 2 (0.33%) had received left kidneys and 1 (0.70%) had received a right ($p = 0.94$). One year graft failure was noted in 23 (3.8%) left kidney recipients and 1 (0.07%) right kidney recipient ($p = 0.06$). Five-year graft failure was observed in 8 (1.32%) left kidney recipients and 2 (1.48%) right kidney recipients ($p = 0.88$) (Table 5). Death with functioning graft was seen in 20 (3.30%) patients belonging to the left group

Table 3 – Donor complications.

Donor complications	Left HALDN (n, %)		Right HALDN (n, %)		p value
Donor open conversions	6	0.99%	3	2.20%	0.46
Donor bleed requiring conversion	1	0.16%	0		
Donor bleed requiring transfusion	6	0.99%	0		
Donor re explorations TOTAL	13	2.2%	2	1.48%	0.87
Splenectomy	2	0.33%	0	0%	–
Small bowel obstruction	3	0.66%	1	0.74%	0.72
Peritonitis	3	0.66%	1	0.74%	0.72
Internal hernia	1	0.16%	0		
Incarcerated hernia	1	0.16%	0		
Seroma	1	0.16%	0		
Bleeding	2	0.33%	0		
Donor surgical site infections	19	3.14%	6	4.44%	0.62
HAP	37	6.12%	3	2.22%	0.11
UTI	22	3.6%	2	1.48%	0.31
Donor median hospital stay in days [Range in days]	4[2–61]	–	4[3–12]	–	0.6
Donor incisional hernia	36	5.90%	7	5.18%	0.36

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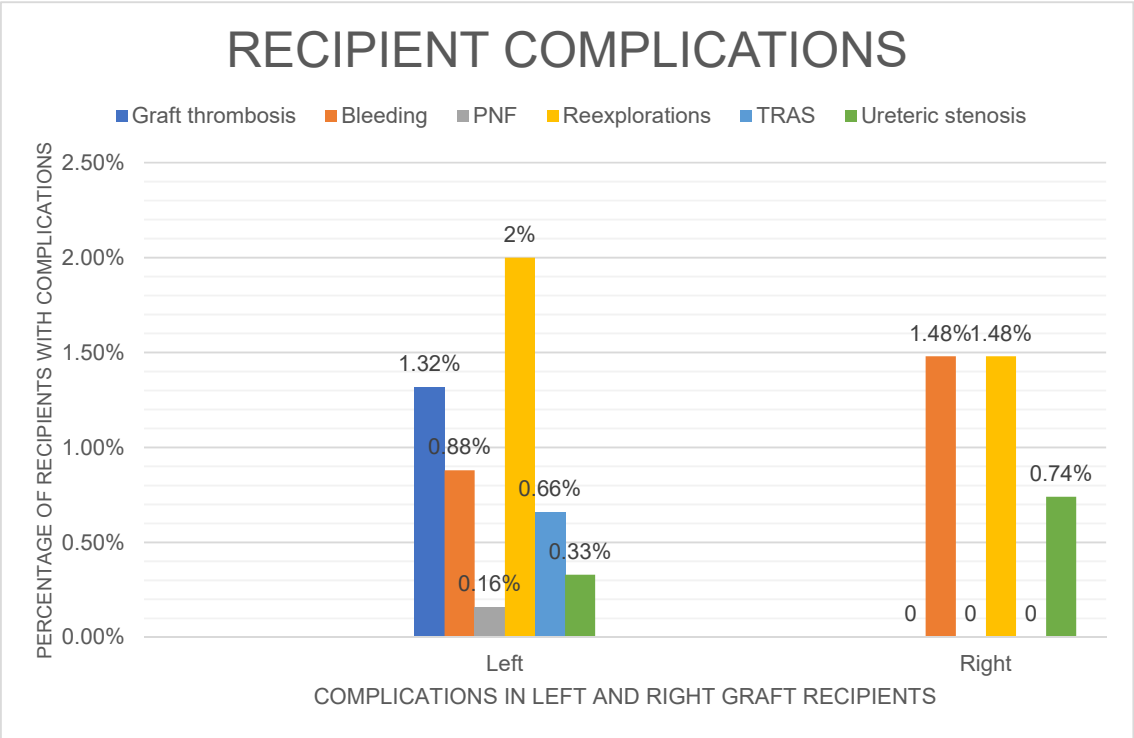

Fig. 1 – Recipient complications: y axis represents percentage of recipients having complications and x axis represents the various complications in left and right recipients.

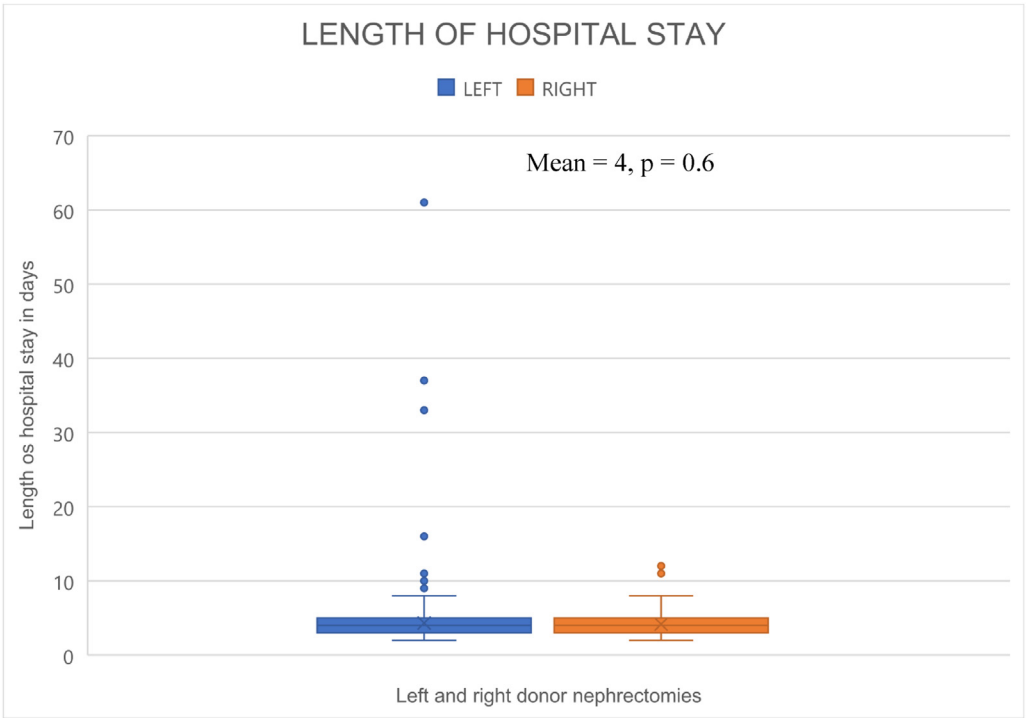

Fig. 2 – Donor length of hospital stay: Box and Whisker plot of hospital stay in days with y axis representing hospital stay in days and x axis representing left and right HALDN donors.

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Table 4 – Recipient complications and graft loss at one year, five years post-transplant.

Recipient complications and graft loss			
Complication	Left HALDN (n, %)	Right HALDN (n, %)	p value
Graft thrombosis	8 (1.32%)	0	
Bleeding	5 (0.80%)	2 (1.48%)	0.23
PNF	1 (0.16%)	0	
Re-explorations	11 (2%)	2 (1.48%)	0.92
TRAS	3 (0.66%)	0	
Ureteric stenosis	2 (0.33%)	1 (0.70%)	0.94
Graft failure at 1 year			
TOTAL	23 (3.80%)	1 (0.70%)	0.06
Thrombosis	8 (1.32%)	0	
PNF	1 (0.16%)	0	
Vascular rejection	1 (0.16%)	0	
Unknown[a]	10 (1.65%)	0	
Bleeding	0	1 (0.70%)	
Recurrent disease	2 (0.33%)	0	
Sepsis	1 (0.16%)	0	
Graft failure at 5 years			
TOTAL	8 (1.32%)	2 (1.48%)	0.88
Atypical HUS	1 (0.16%)	0	
ABMR	0	1 (0.70%)	0.91
Recurrent disease	2 (0.33%)	0	
Unknown[a]	5 (0.82%)	1 (0.70%)	0.91
Death with functioning graft	20 (3.33%)	2 (1.48%)	0.39
Failure in grafts transplanted from donors post conversion (conversions)	0 (6)	0 (3)	

[a] Most of those in retrospect were having chronic allograft nephropathy.

Table 5 – One year and five-year graft loss with causes in left HALDN.

One year graft loss in left donor nephrectomy recipients		
Patient number	Cause	Time to graft loss in months
1–8	Graft thrombosis	<24 h.
9	Unknown	9
10	Unknown	1
11	Unknown	1
12	Unknown	7
13	PNF	
14	MPGN	4
15	Unknown	1
16	Unknown	7
17	Vascular rejection	4
18	Unknown	9
19	MPGN	5
20	Sepsis with graft AKI	3
21	Unknown	8
22	Unknown	8
23	Unknown	3
5-year graft loss in left donor nephrectomy recipients		
24	Atypical HUS	48
25	Unknown	23
26	Unknown	33
27	Recurrent MPGN	14
28	Unknown	17
29	Recurrent IgA nephropathy	39
30	Unknown	13
31	Unknown	16

[a] The only graft loss at one year in right HALDN was due to bleeding. Five-year graft loss in right HALDN were two at 24 months, one due to ABMR and another from unknown cause respectively.

and 2 (1.48%) belonging to the right group ($p = 0.39$) during the whole follow up period.

Discussion

Living Donor Kidney Transplantation (LDKT) currently comprises 28% of overall renal transplant activity in the UK with larger numbers globally.[12] It offers the best outcomes in terms of recipient and graft survival, particularly if carried out pre-emptively.[4,13] Open nephrectomy has universally given way to minimally invasive techniques including the single incision laparoscopic surgery (SILS) technique. Between 2002 and 2020 over 1000 HALDN procedures have been carried out in our centre and is the standard donor nephrectomy technique.

Strengths of this study

The strengths of this study are the large number of patients included and the comprehensive analysis of donor and recipient outcomes linked to laterality of the kidney chosen for donor nephrectomy.

The centre's choice of laterality is made on a combination of factors. The primary indication (44%) was in most donors a favourable vascular anatomy. The second most common reason (41%) was the function of the kidney. Other factors (15%) included renal cysts, calculi, and radiological evidence of scarring. Our experience was comparable to a series reported in the literature.[14]

HALDN evolved after the development of totally laparoscopic nephrectomy due to concerns with warm ischaemia time associated with a totally laparoscopic procedure.[15] Liu et al. in a meta-analysis demonstrated no statistically significant differences in kidney retrieval times and warm ischaemia with right versus left HALDN.[8] A literature review shows WIT ranging from 41 s to 660 s.[3,6,7] In our series the mean warm ischaemia time was 210 s across both groups ($p = 0.47$).

Some RCTs have demonstrated, on occasion, a shorter operating time in right HALDN.[3,6,7] On the contrary a systematic review has also shown a study where right laparoscopic living donor nephrectomy took longer than left.[16] In our series the latter has been true with left HALDN taking an average of 167 min versus right HALDN taking 182 min ($p = 0.003$). This may reflect the greater experience with the left HALDN procedures performed and more caution with the less routine right HALDN. In fact, the operating time for left HALDN did reduce from the first 6-year period to the second 6-year period of this study ($p = 0.01$) whereas the operating time did not change for the right nephrectomy. A methodological problem is that published literature has not been uniform in defining duration of surgery. Some studies describe duration

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from initial skin incision to skin closure while others describe duration as the interval between the time when the skin is incised to the time that renal vessels are stapled.[17]

Cold ischaemia time is another variable which was analysed. A major benefit of living donor kidney transplantation is a short CIT combined with a good quality kidney. Recent evidence suggests minimal detrimental effects on graft function with a CIT of up to 8 h.[18] In our series there was statistically significant difference in the CIT between the left and the right kidneys. In our experience left HALDN took a shorter time compared to right. This in turn reflected on the cold ischaemia time. Another important difference is whether the recipient's transplant was done sequentially or in parallel with the donor operation. In our analysis there was a 1:4 split with 25% of the recipients having their transplants in parallel; almost all of those in paediatric recipients. There were fewer parallel procedures due to logistics and availability of theatres in the adult living donor kidney transplant cohort.

Halgrimson et al. quote the incidence of renovascular complications in HALDN to be 1.1% with higher incidence demonstrated by other authors.[15] Reported conversion rates in the literature range from 0.2% to 6.8%.[7,16] In our series there were 9 (1.21%) conversions in total. All recipient allografts from these donors however had primary and good long-term function after implantation. At our institution, in technically difficult cases, more than one consultant surgeon would scrub and support the colleague. This was especially practised when there was aberrant anatomy, bleeding, difficult dissection, or risk of injury to graft or other structures in the vicinity.

In our centre the standard hand port incision is supra-umbilical midline for left HALDN and infra-umbilical for right HALDN. Post-donation incisional hernia incidence did not differ according to the side of nephrectomy. The reported incidence in the literature is between 0.7%–5.4%. Incisional hernia post-HALDN has been quoted to be a significant cause of donor morbidity and has the same incidence as incisional hernia post open nephrectomy, although it has different causality.[19]

Duration of in-hospital stay after left or right donor nephrectomy was similar at 4 days. Studies have quoted a similar post-operative length of stay with a weighted mean of around 3 days.[15] The shortest hospital stay recorded was 1.2 days by Koscak et al. and longest at 11 days by Ruszt et al.[20] Post-operative complications in donors range from 0 to 40% in literature depending on the type of complications recorded.[5,15,17] Mortality from living donor nephrectomy is extremely low and estimated at 0.02% and the potential for serious life-threatening complications is approximately 0.23%.[5] Most studies do not demonstrate statistically significant donor complications.[6,11,20] Sundaram et al. quote a longer length of hospital stay in right HALDN but there was no difference in our series.[20] No deaths were recorded in our study amongst the donors in the 30-day post donation period and none of the donors developed acute kidney injury (AKI) or failure of the remaining kidney subsequent to donation during the follow up period. Three late deaths more than three years post donation in our donors were due to acute coronary syndrome, cerebrovascular accident and malignancy respectively. Mjoen et al., in 2013 published donor outcomes from a large Norwegian series which indicates a higher risk of donors developing renal failure compared to the normal population.[21] The median time for renal failure to develop was 18 years. A meta-analysis has revealed only two instances of peri-operative death in donors caused by PE and myocardial infarction.[15]

Recipient outcomes were generally similar, with no statistical significance in any of the measured variables according to laterality except renovascular complications which were all in the left nephrectomy group. Given the numbers involved it is difficult to attribute causality to the nephrectomy side. In a prospective single-centre randomised trial conducted from April 2002 to September 2006, Minnee et al. found no statistically significant differences in outcomes in the right or the left group, Hoda et al. replicated the same finding.[3,6] Graft thrombosis is a rare event. A review of graft thromboses in our series found multiple recipient factors, including hypercoagulable state, obesity and hypotension causing the thromboses. PNF was recorded in one paediatric recipient who received a left donor kidney. A review of the literature also did not reveal any statistically significant difference in those outcomes.[1,3,5–7]

Transplant renal artery stenosis (TRAS) was documented in 3 of the recipients who had received left sided kidneys and were successfully treated with angioplasty. There is no underlying theoretical reason for that. None of the recipients of right HALDN grafts developed TRAS. Usually heralded by hypertension, this complication can lead to serious consequences including graft loss and death. Literature quotes an incidence ranging from 1% to 23%.[22]

Implications for clinical practice

This study demonstrates that there are no significant differences in donor and recipient outcomes, if either the left or right kidney is chosen for transplantation in living donor transplants. We presume that recipient renovascular complications being limited in the left donor nephrectomy is down to more left HALDN performed since there was no specific pattern of causality. The complications were also not statistically significant. The choice of kidney should primarily depend on anatomical and functional factors, and donor and recipient surgeons should be reassured that retrieving and transplanting a right sided kidney does not disadvantage either the donor or the recipient. The ultimate decision on laterality should be on MDT discussion. The donor operation or the recipient outcome should not be disadvantaged by lack of experience or concerns of a right donor nephrectomy.

Limitations

While 739 donors had complete data, which were analysed, 121 needed to be excluded due to lack of complete data. It is also a retrospective study, with flaws associated with retrospective data collection.

Given that, initially at least, the right HALDN was performed by the more experienced donor surgeons this could have resulted in fewer complications with the right sided nephrectomy. In the latter half of the study, however, 41% right HALDN were performed by more junior surgeons.

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Conclusion

This large series demonstrates that outcomes after right donor nephrectomy are not inferior to the left donor nephrectomy with no detrimental outcomes to both donors and recipients. The right kidney should be chosen when it has favourable anatomical and functional factors over the left. Donors and recipients should not be disadvantaged by teams with minimal or little experience in right sided donor nephrectomy. With a significant mismatch between kidneys available for transplantation and recipients on the waiting list, all effort should be made by living donor centres to take the same unbiased approach to either kidney in living donor transplantation. Mentoring less experienced donor surgeons to perform a right nephrectomy, which can be technically difficult, would be one of the approaches in attaining this objective.

Authorship

OV and TA conceptualised the study. OV performed data collection and analysis. OV and VS wrote the manuscript. AA provided writing and editorial review ZM provided input with data management and analysis, MS analysed the data and provided statistical advice, TA provided conceptual guidance, revision and editorial review. All authors reviewed the manuscript and contributed to revisions.

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Declaration of competing interest

The authors declare explicitly that there are no conflicts of interest associated with this study.

REFERENCES

1. Keller JE, Dolce CJ, Griffin D, Heniford BT, Kercher KW. Maximizing the donor pool: use of right kidneys and kidneys with multiple arteries for live donor transplantation. *Surg Endosc* 2009;**23**(10):2327–31.
2. Kavoussi LR. Laparoscopic donor nephrectomy. *Kidney Int* 2000;**57**(5):2175–86.
3. Minnee RC, Bemelman WA, Maartense S, Bemelman FJ, Gouma DJ, Idu MM. Left or right kidney in hand-assisted donor nephrectomy? A randomized controlled trial. *Transplantation* 2008;**85**(2):203–8.
4. Wolfe RA, Ashby VB, Milford EL, Ojo AO, Ettenger RE, Agodoa LY, et al. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. *N Engl J Med* 1999;**341**(23):1725–30.
5. Levey HR, Rais-Bahrami S, Richstone L, Kavoussi LR. Laparoscopic live donor nephrectomy: a technical road map. *J Endourol* 2011;**25**(2):201–8.
6. Hoda MR, Greco F, Wagner S, Heynemann H, Fornara P. Prospective, nonrandomized comparison between right- and left-sided hand-assisted laparoscopic donor nephrectomy. *Transplant Proc* 2011;**43**(1):353–6.
7. Percegona LS, Meyer F, Machado C, Bignelli AT, Riella MC, Santos LS. Hand-assisted laparoscopic nephrectomy in living donors. *Transplant Proc* 2006;**38**(6):1870–1.
8. Liu N, Wazir R, Wang J, Wang KJ. Maximizing the donor pool: left versus right laparoscopic live donor nephrectomy–systematic review and meta-analysis. *Int Urol Nephrol* 2014;**46**(8):1511–9.
9. Velidedeoglu E, Williams N, Brayman KL, Desai NM, Campos L, Palanjian M, et al. Comparison of open, laparoscopic, and hand-assisted approaches to live-donor nephrectomy. *Transplantation* 2002;**74**(2):169–72.
10. Broe MP, Galvin R, Keenan LG, Power RE. Laparoscopic and hand-assisted laparoscopic donor nephrectomy: a systematic review and meta-analysis. *Arab J Urol* 2018;**16**(3):322–34.
11. Wang K, Zhang P, Xu X, Fan M. Right versus left laparoscopic living-donor nephrectomy: a meta-analysis. *Exp Clin Transplant* 2015;**13**(3):214–26.
12. Bailey PK, Wong K, Robb M, Burnapp L, Rogers A, Courtney A, et al. Has the UK living kidney donor population changed over time? A cross-sectional descriptive analysis of the UK living donor registry between 2006 and 2017. *BMJ Open* 2020;**15;10**(6):e033906.
13. Asderakis A, Augustine T, Dyer P, Short C, Campbell B, Parrott NR, et al. Pre-emptive kidney transplantation: the attractive alternative. *Nephrol Dial Transplant* 1998;**13**(7):1799–803.
14. Buell APA, Edye F, Johnson M, Li C, Koffron A, Cho E, et al. Are concerns over right laparoscopic donor nephrectomy unwarranted? *Ann Surg* 2001;**233**(5):645–51.
15. Halgrimson WR, Campsen J, Mandell MS, Kelly MA, Kam I, Zimmerman MA. Donor complications following laparoscopic compared to hand-assisted living donor nephrectomy: an analysis of the literature. *J Transplant* 2010;**2010**:825689.
16. Broudeur L, Karam G, Chelghaf I, De Vergie S, Rigaud J, Perrouin Verbe MA, et al. Feasibility and safety of laparoscopic living donor nephrectomy in case of right kidney and multiple-renal artery kidney: a systematic review of the literature. *World J Urol* 2020;**38**(4):919–27.
17. Kaushik M, Bagul A, Yates PJ, Elwell R, Nicholson ML. Comparison of techniques of vascular control in laparoscopic donor nephrectomy: the Leicester experience. *Transplant Proc* 2006;**38**(10):3406–8.
18. Nath J, Hodson J, Canbilen SW, Al Shakarchi J, Inston NG, Sharif A, et al. Effect of cold ischaemia time on outcome after living donor renal transplantation. *Br J Surg* 2016;**103**(9):1230–6.
19. Ahmed Z, Mosca I, Dirix M, Tamburrini R, Kessaris N, Mamode N. Incisional herniation following hand assisted laparoscopic donor nephrectomy: incidence, impact and aetiology [abstract]. *Am J Transplant* 2015;**15**(suppl 3). https://atcmeetingabstracts.com/abstract/incisional-herniation-following-hand-assisted-laparoscopic-donor-nephrectomy-incidence-impact-and-aetiology/.
20. Sundaram CP, Martin GL, Guise A, Bernie J, Bargman V, Milgrom M, et al. Complications after a 5-year experience

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with laparoscopic donor nephrectomy: the Indiana University experience. *Surg Endosc* 2007;**21**(5):724–8.
21. Mjøen G, Hallan S, Hartmann A, Foss A, Midtvedt K, Øyen O, et al. Long-term risks for kidney donors. *Kidney Int* 2014;**86**(1):162–7.
22. Kadoya Y, Zen K, Matoba S. Endovascular treatment of transplant renal artery stenosis based on hemodynamic assessment using a pressure wire: a case report. *BMC Cardiovasc Disord* 2018;**18**(1):172.

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