Transplant International

Transplant International ISSN 0934-0874

ORIGINAL ARTICLE

Left versus right deceased donor renal allograft outcome

Paul J. Phelan,[1] William Shields,[2] Patrick O'Kelly,[1] Melissa Pendergrass,[2] John Holian,[1] Joseph J. Walshe,[1] Colm Magee,[1] Dilly Little,[2] David Hickey[2] and Peter J. Conlon[1]

1 Department of Nephrology, Beaumont Hospital, Dublin, Ireland
2 Department of Transplantation, Beaumont Hospital, Dublin, Ireland

Keywords
allograft outcome, delayed graft function, left kidney, renal transplantation, right kidney.

Correspondence
Dr Paul J. Phelan, Department of Nephrology, Beaumont Hospital, Dublin 9, Ireland. Tel.: +353 1 8092732; fax: +353 1 8092899; e-mail: paulphel@gmail.com

Received: 11 May 2009
Revision requested: 29 May 2009
Accepted: 13 July 2009

doi:10.1111/j.1432-2277.2009.00933.x

Summary

It has been suggested that the left kidney is easier to transplant than the right kidney because of the longer length of the left renal vein, facilitating the formation of the venous anastomosis. There are conflicting reports of differing renal allograft outcomes based on the side of donor kidney transplanted (left or right).We sought to determine the effect of side of donor kidney on early and late allograft outcome in our renal transplant population. We performed a retrospective analysis of transplanted left–right deceased donor kidney pairs in Ireland between January 1, 1998 and December 31, 2008. We used a time to death-censored graft failure approach for long-term allograft survival and also examined serum creatinine at different time points post-transplantation. All outcomes were included from day of transplant onwards. A total of 646 transplants were performed from 323 donors. The incidence of delayed graft function was 16.1% in both groups and there was no significant difference in acute rejection episodes or serum creatinine from 1 month to 8 years post-transplantation. There were 47 death-censored allograft failures in the left-sided group compared to 57 in the right-sided group ($P = 0.24$). These observations show no difference in renal transplant outcome between the recipients of left- and right-sided deceased donor kidneys.

Introduction

Generally, the left kidney is harvested for living donor transplantation. This is because the left kidney has a longer renal vein which facilitates the implantation process [1–3]. Registry reports of kidneys transplanted from the late 1980s to the early 1990s suggested that early deceased donor allograft survival was superior with left-sided kidneys [4,5]. United Network for Organ Sharing (UNOS) data reported from transplants between 1988 and 1991 [4] showed 3-month allograft survival rates of 90.4% in recipients of left-sided kidneys versus 85.0% in recipients of right-sided kidneys ($P = 0.0005$). This effect appeared to be lost with longer follow-up and beyond 1 year, there was no effect seen in either report. Early allograft survival in this era has greatly improved compared with that reported in the above studies, with 1-year graft survival being well over 90% [6]. More recently, a study from an Australian center suggested no effect on deceased donor allograft outcome between left and right kidneys [7]. Our aim was to assess the effect of side (left or right) of donor kidney transplanted on allograft outcome in a European population of deceased donor transplants, by examining early and late allograft outcome measures.

Patients and methods

Patients

Our institution is the only kidney transplantation center in the Republic of Ireland, performing 130–150 transplants per year. We conducted a retrospective analysis of deceased donor kidneys transplanted in Ireland between January 1, 1998, and December 31, 2008. We excluded unpaired single kidneys, nephron-dosing (dual kidney) transplants, and en-bloc kidneys from analysis, and

included only paired allografts. Patient demographic data were available from our renal patient database (CLINICAL VISION 3.4a version 1.1.34.1, Clinical Computing, Cincinnati, Ohio, USA). For the purpose of the study, we defined delayed graft function as the need for dialysis in the first week post-transplantation. Patients were censored at death and followed until allograft failure or until the date of study analysis in March 2009.

Surgeons performed operations using a standard technique and based on a rolling on-call rota. First-time transplants were generally transplanted into the right side of the recipient. As described by Chopin *et al.* [8], our surgeons routinely used vena caval extension for all right-sided kidneys to obtain additional length for the right renal vein. Donation after cardiac death was not employed at our center during the study period.

Initial medications

Initial immunosuppression consisted of a calcineurin inhibitor [cyclosporin (4 mg/kg twice daily; prior to 2001) or tacrolimus (0.2 mg/kg/day in two divided doses; 2001 onwards)], an anti-metabolite [azathioprine (2 mg/kg daily; prior to 2002) or mycophenolate mofetil (500 mg twice daily; 2002 onwards)], and prednisolone 20 mg. Cyclosporin doses were adjusted to achieve troughs of 200–250 ng/ml in the early post-transplant period, with maintenance levels of 120–180 ng/ml after 6 months. Tacrolimus doses were titrated to troughs of 10–12 ng/ml in the early post-transplant period, gradually decreasing to maintenance levels of 6–8 ng/ml at 1 year. Prednisolone was weaned gradually to 5 mg/day by 3 months post-transplantation. The decision on whether to continue corticosteroids or not was made based on immunological risks (prior transplantation, degree of HLA mismatch, and peak panel reactive antibodies level) on a per-patient basis. Perioperative heparin prophylaxis against venous thromboembolism was not routinely used. Patients at risk for CMV disease (recipient, donor, or both CMV positive) received CMV prophylaxis, which consisted of valaciclovir until 2004 and valganciclovir thereafter (dosage adjusted for renal function). All patients received co-trimoxazole for prevention of Pneumocystis pneumonia. Both prophylactic agents were used in the first 4 months post-transplantation.

Statistical analysis

Demographic variables were compared using either Pearson Chi-squared or Kruskal–Wallis tests, depending on whether categorical or continuous variables were analyzed. Kaplan–Meier methods were used to estimate allograft survival and to construct survival curves. Log Rank tests were conducted to establish equality of allograft outcome for the groups. In addition, potential confounding variables were included in a multifactorial Cox Proportional Hazards model, where relative risk of right versus left kidney was analyzed. Software used in the analysis was STATA (version 10; College Station, TX, USA). A P-value <0.05 was considered to be statistically significant.

Results

Patient characteristics

A total of 646 transplant operations were performed from 323 donors during the study period. Baseline demographic information was similar between the groups, with no significant differences identified (see Table 1). In particular, median cold ischemia time was identical in the two groups. Matching donor characteristics were found because of the use of paired kidneys, with a median donor age of 43 years and a 55/45% male/female ratio. The causes of donor death were cerebrovascular accidents (49.4%), trauma (43.3%), hypoxia (3.1%), and other/unknown causes (4.2%).

Allograft function

The incidence of delayed graft function was identical in both groups, occurring in 52 patients in each group (16.1%). The incidence of acute rejection was 20.4% in left-sided recipients vs. 18.6% in right-sided recipients ($P = 0.55$).

Median serum creatinine [range] concentrations for surviving allografts were similar in the left and right kidney recipient groups at 3 months (136 μmol/l [55–369 μmol/l] vs. 135 μmol/l [81–332 μmol/l], respectively, $P = 0.42$); 1 year (130 μmol/l [68–313 μmol/l]

Table 1. Baseline recipient characteristics.

Variable	Left-sided recipient	Right-sided recipient	*P*-value
Age (years)	46.4 [33.4–58.2]	47.9 [37.9–57.3]	0.30
Male (%)	61.0	64.7	0.33
Diabetes Mellitus (%)	6.2	6.5	0.87
Re-transplant (%)	13.3	16.1	0.32
HLA Mismatches	3 [2–4]	3 [2–4]	0.64
Peak PRA %	80.8/9.4/9.8*	78.3/12.0/9.7*	0.60
CIT (h)	19 [17–23]	19 [17–23]	0.74

PRA, Panel reactive antibodies (determined by use of the complement-dependent cytotoxicity assay, NIH Basic technique); CIT, cold ischemia time.

Results are expressed as median [inter-quartile range] for continuous data and percentages for categorical data.

*These values represent PRA in the following ranges 0–10%/11–49%/50–100%.

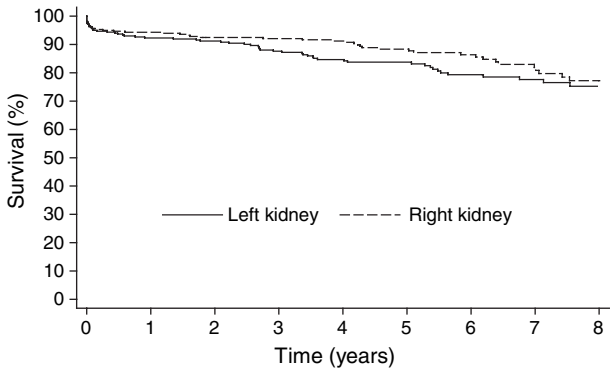

Figure 1 Kaplan–Meier curve showing death-censored allograft survival based on side of kidney transplanted ($P = 0.24$).

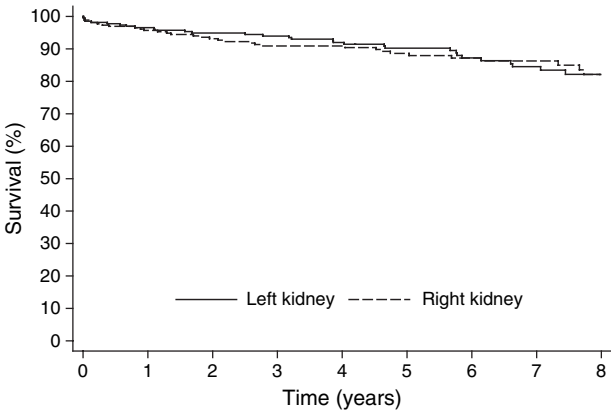

Figure 2 Kaplan–Meier curve showing patient survival based on side of kidney transplanted ($P = 0.69$).

vs. 125 μmol/l [72–300 μmol/l], $P = 0.76$); 3 years (128 μmol/l [66–548 μmol/l] vs. 121 μmol/l [71–396 μmol/l], $P = 0.43$); 5 years (126 μmol/l [65–509 μmol/l] vs. 125 μmol/l [66–487 μmol/l], $P = 0.71$); and 8 years (118 μmol/l [68–279 μmol/l] vs. 132 μmol/l [66–313 μmol/l], $P = 0.20$), (creatinine can be converted to mg/dl by multiplying the result in μmol/l by 0.113).

Death-censored allograft and patient survival

There were 104 graft failures in the follow-up period, involving 47 right-sided and 57 left-sided kidneys. The causes of graft failure in the left kidney group included chronic allograft nephropathy (21%, 36.8%), recurrence of primary disease (8%, 14.0%), allograft rejection (15%, 26.3%), and unknown causes (13%, 22.8%). The causes of graft loss in the right kidney group consisted of chronic allograft nephropathy (20%, 42.6%), recurrence of primary disease (7%, 14.9%), allograft rejection (7%, 14.9%), and unknown causes (13%, 27.7%). Death-censored allograft survival at 1, 3, 5, and 8 years was 94.3%, 92.1%, 88.4%, and 77.2% for right-sided kidneys compared to 92.3%, 87.6%, 83.8%, and 75.2% for left-sided kidneys (overall $P = 0.24$).

There were 74 deaths recorded, 39 right-sided recipients and 35 left-sided recipients. Patient survival at 1, 3, 5, and 8 years was 95.7%, 90.9%, 88.6%, and 82.1% for right-sided kidneys compared to 96.6%, 94.0%, 90.2%, and 82.2% for left-sided kidneys (overall $P = 0.69$) (see Figs 1 and 2). Two multifactorial Cox regression analyses are presented in Table 2 for graft and patient survival. Results confirm a lack of effect with side of kidney in the presence of several possible confounder variables.

Discussion

We demonstrated no effect on delayed graft function or long-term allograft survival between recipients of left and right kidney transplants. Moreover, renal function, as measured by serum creatinine, was similar in the two groups. Previous work in a Dutch population by Roodnat *et al.* examined multiple transplant variables, including donor and recipient factors, and their relationship to allograft outcome in 1124 kidney transplants [9]. They compared overall numbers of left-sided to right-sided allografts and found no difference in death-censored allograft survival. However, they did not use a paired allograft approach and there were 98 more right-sided

Table 2. Multifactorial model for allograft outcome and patient survival.

	Graft survival		Patient survival	
Variable	Hazard ratio (95% CI)	*P*-value	Hazard ratio (95% CI)	*P*-value
Right kidney	0.799 (0.537–1.191)	0.27	1.025 (0.610–1.722)	0.93
Age at transplant	0.995 (0.981–1.010)	0.55	1.078 (1.053–1.103)	0.001
HLA mismatches	0.999 (0.860–1.160)	0.99	1.227 (0.991–1.529)	0.06
CIT	1.029 (0.993–1.067)	0.10	0.999 (0.951–1.048)	0.97
PRA	1.683 (1.280–2.213)	<0.001	2.172 (1.411–3.344)	<0.001
Sex	1.333 (0.865–2.055)	0.19	1.072 (0.607–1.893)	0.81
Acute rejection	1.782 (1.166–2.724)	0.008	1.018 (0.517–2.004)	0.96

PRA, panel reactive antibodies; CIT, cold ischemia time.

kidneys than left-sided. We considered direct comparison of right and left kidneys from the same donor to be a more accurate method which would account for other donor variables, such as donor age, gender, cause of death, and co-morbidities. Our approach was similar to that used by Johnson *et al.* [7]. However, in that study, the authors reported a very low event rate, with a mean death-censored survival of 100% at 1 year and 97.9% at 3 years post-transplantation. With this low event rate, the study was unlikely ever to show a significant result. Moreover, if there is a technical difference between the left and right kidneys, one would expect any difference in outcome to be a result of a surgical issue, which therefore would become evident in the early post-transplantation period.

While our study does verify results from the other single-center studies mentioned above, it does not support UNOS registry data from the 1990s, which suggested superior early outcomes with left-sided allografts. Allograft survival from that era was markedly inferior to the results we have reported. Moreover, rates of delayed graft function, at 25–30%, were reported to be much higher during the 1990s [10,11] compared to our mean of 16%. Modern improvements in kidney transplant outcome may have abated any benefit associated with left-sided allografts and possibly accounts for the lack of this effect in more recent studies.

Adding to the body of evidence against the existence of a difference between left and right transplanted kidneys are split GFR measurement studies. These studies have compared measured GFR between left- and right-sided kidneys and have generally not shown a statistically significant difference in renal function between the two sides [12,13]. Both gadolinium-enhanced magnetic resonance angiography and radioisotope scanning have been employed in this study. This leaves us with surgical challenges resulting from anatomical differences between left and right kidneys as the remaining variable, which may, in theory, affect allograft outcome between the two sides.

Traditionally, the left kidney was felt to be the easier kidney to form the venous anastomosis, given the longer length of the left renal vein [2]. However, the left renal vein has additional properties which can present challenges for the transplant surgeon. These include anatomical variations of the posterior tributaries and [14] the presence of pre- and retro-aortic veins [15] and of a double left renal vein [16]. These anomalies may negate any pre-existing advantage attained using the left kidney with its longer renal vein. Excellent results have been reported in living-kidney donation using right-sided allografts, with graft survival being equivalent to that of left-sided donors [17,18]. Moreover, we employ vena caval extension to facilitate venous anastomosis of the right kidney. With this technique, a segment of the inferior vena cava is recovered with the right kidney. This is especially useful when the right renal vein is particularly short and when the recipient has a high body mass index. The extended venous system of our right-sided allografts is possibly a reason why no effect on outcome was demonstrated.

There are some limitations to this study. First, we acknowledge the inherent weaknesses of any retrospective, single-center study. However, confining the study to one center reduces the confounding effects of multiple surgeons and multiple perioperative protocols. Second, left and right organs may have been allocated by the surgeon in a nonrandomized fashion because of a recipient or technical issue. However, the similar cold ischemia times in the two groups suggest that kidneys were allocated to each recipient in an arbitrary fashion. Last, we have used serum creatinine rather than estimated GFR for determining renal function.

In conclusion, by comparing paired kidney transplants where caval extension is employed for right-sided kidneys, the side of the deceased donor kidney (left or right) appears to have no impact on early or late allograft outcome.

Authorship

WS: collected data and performed study. POK: analyzed data and performed study. MP: collected data. JH and CM: performed critical revision. JJW, DL, and DH: designed study. PJC: final approval for submitted version. PJP: designed, performed study and wrote paper.

Funding

There are no financial disclosures for any authors.

References

1. Mandal AK, Cohen C, Montgomery RA, Kavoussi LR, Ratner LE. Should the indications for laparascopic live donor nephrectomy of the right kidney be the same as for the open procedure? Anomalous left renal vasculature is not a contraindication to laparoscopic left donor nephrectomy. *Transplantation* 2001; **71**: 660.
2. Satyapal KS, Kalideen JM, Singh B, Haffejee AA, Robbs JV. Why we use the donor left kidney in live related transplantation. *S Afr J Surg* 2003; **41**: 24.
3. Buell JF, Abreu SC, Hanaway MJ, *et al.* Right donor nephrectomy: a comparison of hand-assisted transperitoneal and retroperitoneal laparoscopic approaches. *Transplantation* 2004; **77**: 521.
4. Gjertson DW. Multifactorial analysis of renal transplants reported to the United Network for Organ Sharing Registry. *Clin Transpl* 1992; 299.

5. Feduska NJ Jr, Cecka JM. Donor factors. *Clin Transpl* 1994; 381.
6. Hariharan S, Johnson CP, Bresnahan BA, Taranto SE, McIntosh MJ, Stablein D. Improved graft survival after renal transplantation in the United States, 1988 to 1996. *N Engl J Med* 2000; **342**: 605.
7. Johnson DW, Mudge DW, Kaisar MO, *et al.* Deceased donor renal transplantation–does side matter? *Nephrol Dial Transplant* 2006; **21**: 2583.
8. Chopin DK, Popov Z, Abbou CC, Auvert JM. Use of vena cava to obtain additional length for the right renal vein during transplantation of cadaveric kidneys. *J Urol* 1989; **141**: 1143.
9. Roodnat JI, Mulder PG, Van Riemsdijk IC, Jzermans JN, van Gelder T, Weimar W. Ischemia times and donor serum creatinine in relation to renal graft failure. *Transplantation* 2003; **75**: 799.
10. Bleyer AJ, Burkart JM, Russell GB, Adams PL. Dialysis modality and delayed graft function after cadaveric renal transplantation. *J Am Soc Nephrol* 1999; **10**: 154.
11. Lechevallier E, Dussol B, Luccioni A, *et al.* Posttransplantation acute tubular necrosis: risk factors and implications for graft survival. *Am J Kidney Dis* 1998; **32**: 984.
12. Shokeir AA, Gad HM, El Diasty T. Role of radioisotope renal scans in the choice of nephrectomy side in live kidney donors. *J Urol* 2003; **170**: 373.
13. El-Diasty TA, El-Ghar ME, Shokeir AA, *et al.* Magnetic resonance imaging as a sole method for the morphological and functional evaluation of live kidney donors. *BJU Int* 2005; **96**: 111.
14. Raheem OA, O'Brien M, Glacken P, Mohan P, Hickey DP. A review of the anatomical variations of the posterior tributaries of the left renal vein. *Ir J Med Sci* 2008; **177**: 59.
15. Satyapal KS, Kalideen JM, Haffejee AA, Singh B, Robbs JV. Left renal vein variations. *Surg Radiol Anat* 1999; **21**: 77.
16. Toda R, Iguro Y, Moriyama Y, Hisashi Y, Masuda H, Sakata R. Double left renal vein associated with abdominal aortic aneurysm. *Ann Thorac Cardiovasc Surg* 2001; **7**: 113.
17. Swartz DE, Cho E, Flowers JL, *et al.* Laparoscopic right donor nephrectomy: technique and comparison with left nephrectomy. *Surg Endosc* 2001; **15**: 1390.
18. Dols LF, Kok NF, Alwayn IP, Tran TC, Weimar W, Ijzermans JN. Laparoscopic donor nephrectomy: a plea for the right-sided approach. *Transplantation* 2009; **87**: 745.

