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CONGRESS PAPER

Monolateral placement of both kidneys in dual kidney transplantation: low surgical complication rate and short operating time*

Burcin Ekser,[1] Nicola Baldan,[1] Giuseppe Margani,[1] Lucrezia Furian,[1] Laura Frison,[1] Marialuisa Valente[2] and Paolo Rigotti[1]

1 Kidney and Pancreas Transplantation Unit, Department of Surgery and Organ Transplantation, University of Padova, Padova, Italy
2 Institute of Pathology, University of Padova, Padova, Italy

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Correspondence
Paolo Rigotti MD, Centro Trapianti di Rene e Pancreas, Clinica Chirurgica 3, Department of Surgery and Organ Transplantation, Via Giustiniani 2, 35128 Padova, Italy. Tel.: +390498211759; fax: +390498213152; e-mail: traprepa@unipd.it

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Summary

Dual kidney transplantation (DKT) from marginal donors is increasingly used at many centers to help cope with the organ shortage problem. The disadvantages of DKT consist in longer operating times and the risk of surgical complications. DKT can be performed in two ways, i.e. using monolateral or bilateral procedures. From October 1999 to June 2005, 58 DKTs were performed at our unit. In 29 cases (group I), the kidneys were extraperitoneally placed bilaterally in the iliac fossae via two separate incisions; as of June 2003, monolateral kidney placement was preferred in 29 cases, whenever compatible with the recipient's morphological status (group II). After a mean follow-up of 51 ± 19 months for group I and 15 ± 7 months for group II, all patients are alive with 1-year graft survival rates of 93% and 96%, respectively. Mean operating times were 351 ± 76 min in group I and 261 ± 31 min in group II ($P = 0.0001$). The mean S-creatinine levels in groups I and II were 132 ± 47 and 119 ± 36 μmol/l, respectively, at 1 year. We observed eight surgical complications in group I and seven in group II. Both techniques proved safe, with no differences in surgical complication rates. The monolateral procedure has the advantage of a shorter operating time and the contralateral iliac fossa remains available for further retransplantation procedures.

Introduction

Organ shortage remains one of the major problems of kidney transplantation so the use of 'expanded-criteria donors' has become more and more frequent [1–4]. Because the outcome of kidney transplantation using organs from such donors is not always satisfactory [5], the use of both kidneys into one recipient (dual kidney transplantation, DKT) has been suggested to increase the nephron mass and improve the function and survival of these elderly grafts [6–9].

Since the first DKT was reported in 1996 [9], many centers now perform DKT using different organ selection criteria and surgical techniques [4,7,10–12], including the bilateral placement of both kidneys, intra- or extra-peritoneally [9], through two separate Gibson incisions or one midline incision [3], and the monolateral placement of both kidneys extraperitoneally through a single Gibson incision [13]. The issue of which surgical technique to use for this procedure is very relevant because the potential disadvantages of DKT include a longer operating time and greater surgical risk.

This study reviews our results with DKT and compares the monolateral versus bilateral placement of kidneys in terms of graft and patient survival rates, graft function and surgical complications.

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Materials and methods

From October 1999 to June 2005, 58 patients underwent DKT at our center. These patients were selected from among those already on our waiting list with no prior kidney transplant, history of pelvic surgery or voluminous polycystic kidneys. Specific informed consent to the DKT procedure was also required.

Kidneys were selected for use in DKT on the basis of donor risk factors, e.g. age, cause of death, concomitant disease, renal function (serum creatinine and creatinine clearance calculated according to the Cockroft formula), macroscopic evaluation and renal histology, as previously described [11]. Renal biopsies were taken using a 16-gauge Trucut needle and histological findings were scored according to the scale described by Karpinski et al. [14] and by Remuzzi et al. [8].

Surgical procedures

In the first 27 cases, kidneys were extraperitoneally placed bilaterally in the iliac fossae through two bilateral Gibson incisions using external iliac vessels, as described by Johnson et al. [9] (group I). From June 2003 onwards, monolateral kidney placement was preferred whenever compatible with the recipient's morphological status (group II): the procedure started as a monolateral operation in all patients; in the event of an excessive mismatch in size between the kidneys and the pelvis, the transplant was performed as a bilateral procedure (two cases who were evaluated as group I).

In the monolateral placement of the two transplants, the kidneys are harvested *en-bloc* with the donor's inferior vena cava (IVC) and separated at the back table, leaving the whole vena cava to the right kidney. The IVC is cut above and below the opening of the left renal vein and the suprarenal and infrarenal lumens are closed with running or mechanical sutures, the incorporated IVC segment thereby lengthening the right renal vein [15].

The classic Gibson incision is made, preferably on the right side, and extended to the transverse umbilical line. After sliding the peritoneum to the distal part of the common iliac artery and the external iliac artery, extraperitoneally, the external iliac vein is mobilized by binding and section of the hypogastric vein(s). The right kidney is placed superiorly. The extended renal vein and the renal artery of the right kidney are anastomosed end-to-side to the mobilized external iliac vein and to the external iliac artery immediately after the common iliac artery bifurcation. We use the aorta patch for arterial anastomosis whenever feasible. After revascularization, the extra length of the right renal vein enables the kidney to be positioned superior-laterally in the lower right flank.

The left donor kidney is transplanted inferiorly with the clamps placed distally to the anastomoses of the right kidney so as to maintain the perfusion of the first transplanted kidney. The renal artery and vein of the left kidney are end-to-side anastomosed to the external iliac vessels and then the left kidney is placed inferior-medially.

Two separate extravesical ureteroneocystostomies are performed according to the Lich-Gregoir technique with a double J stent for each ureter, leaving the ureter of the upper transplanted kidney lateral to the lower one. This course of action was preferred because of the lateral position of the upper kidney with respect to the lower kidney (Fig. 1).

A central venous line (CVL) was placed in all patients at the time of surgery and removed on the third postop-

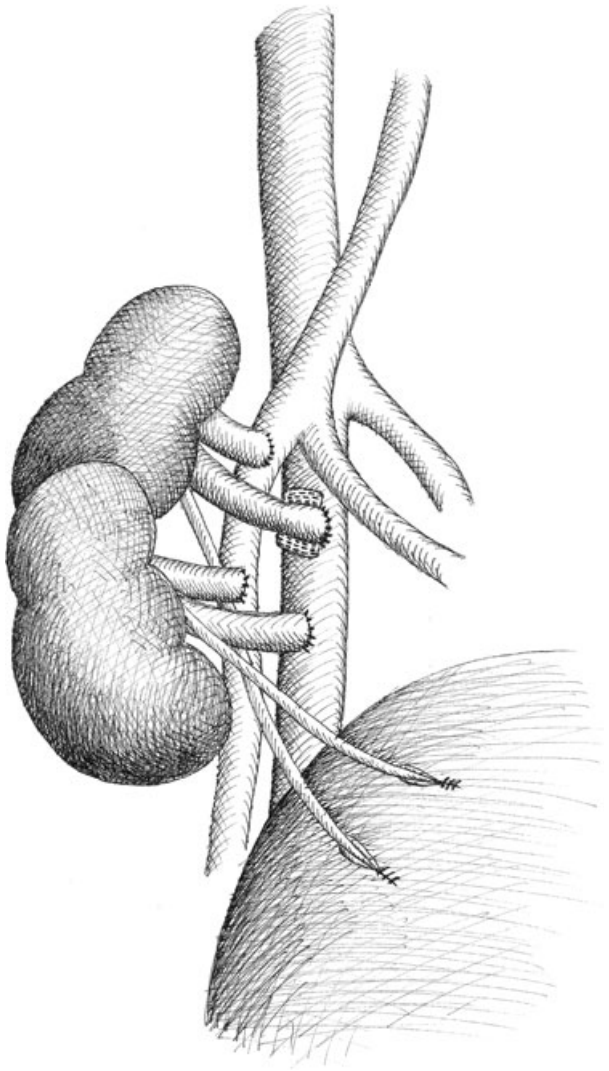

Figure 1 Monolateral placement of both kidneys in dual kidney transplantation.

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erative day or at the end of Antithymoglobin (ATG) infusion. If a CVL was used for hemodialysis, it was removed when renal function was recovered.

Immunosuppressive therapy

Immunosuppression was based on triple drug therapy. A cyclosporine, mycophenolate mofetil (MMF) and steroid regimen was used in 24 patients, while a sirolimus, mycophenolate mofetil and steroid regimen was preferred in 34 patients treated after April 2003. The cyclosporine A (CsA)-based immunosuppressive regimen consisted of: CsA 8 mg/kg/day p.o. and was then adjusted to achieve 12-h whole-blood trough levels of 200–300 ng/ml for the first 3 months and 100–150 ng/ml thereafter; MMF 2 g/day and corticosteroids, beginning at the time of transplantation (starting dose 500 mg of methylprednisolone) and than tapered to 4 mg daily by 90 days post-transplantation. In 19 of these patients, antibody induction was administered with either ATG (five patients) for 3–5 days (mean total dose: 6.1 ± 0.8 mg/kg) or basiliximab (14 patients) 20 mg i.v. on days 0 and 4 (two doses). The sirolimus-based immunosuppressive protocol (33 patients) consisted of ATG induction starting on day 0 (2 mg/kg), tapered to 1.5 mg/kg (day 1), 1.25 mg/kg (day 2), 1.0 mg/kg (day 3), and 0.625 mg/kg (days 4–5); sirolimus 8–10 mg beginning 24 h after transplantation, then 4–6 mg/day, subsequently adjusting the does to maintain serum trough levels of 8–12 ng/ml for the first 3 months, then 5–10 ng/ml; MMF 1 g/day beginning on post-op day 5, and corticosteroids beginning at the time of transplantation (starting dose 500 mg of methylprednisolone) and then tapered to 4 mg daily by 90 days later. Table 2 provides further details on the immunosuppression in the two groups.

Rejection treatment consisted in steroid pulses of 500 mg of methylprednisolone for 3 days, ATG treatment for steroid-resistant rejections and plasmapheresis in the event of humoral rejection demonstrated by the presence of C4d+ in renal biopsy.

Early follow-up

Delayed graft function (DGF) was defined as the need for dialysis in the first postoperative period. The day of last dialysis marked the end of DGF.

After transplantation, Doppler ultrasound was carried out on a daily basis in cases of DGF until renal function was restored. A ^{99m}Tc-MAG3 nuclear scan of the transplants was also performed in every recipient, irrespective of kidney function, on the fifth postoperative day and as necessary thereafter.

Variables and statistics examined

We reviewed our data to compare the incidence of primary nonfunction, DGF, acute rejection, surgical complications, serum creatinine at discharge and after 3, 6 and 12 months, graft and patient survival rates and causes of graft loss. Student's *t*-test, Fisher's exact test and the Kruskal–Wallis or Mann–Whitney tests were used to analyze differences between quantitative and qualitative variables and all values are reported as mean ± 1 SD (standard deviation). Kaplan–Meier analysis was used to calculate graft and patient survival rates.

Results

Donor and recipient characteristics are shown in Tables 1 and 2, respectively. Results are summarized in Table 3. All patients are alive after a mean follow-up of 51 ± 19 months for group I and 15 ± 7 months for group II. The overall 6-month and 1-year graft survival rates are 96% and 94%. Actuarial 6-month and 1-year graft survival rates are 97% and 93% in group I and 96% and 96% in group II, respectively.

Table 1. Donor demographics.

	Group I (bilateral placement)	Group II (monolateral placement)	*P*
Number	29	29	
Age (range) (years)	72.3 ± 4.7 (64–85)	73.4 ± 4.9 (55–79)	ns
Gender (M/F)	13/16	11/18	
Body mass index (kg/m^2)	25.1 ± 4.3	25.3 ± 3.6	ns
Cause of death (CVA) (%)	83	83	ns
History of hypertension (%)	83	52	0.023
History of diabetes (%)	14	3	ns
Serum creatinine (μmol/l)	85.8 ± 29.2	80.4 ± 30.1	ns
Calculated creatinine clearance (ml/min)	70.4 ± 35.3	66.4 ± 27.2	ns
Histological score*	4.0 ± 1.1	4.2 ± 1.1	ns

All values are reported as mean ± SD. CVA, cerebrovascular accident.
*Histological scores indicate the worse score of both kidneys.

Table 2. Recipient demographics.

	Group I (bilateral placement)	Group II (monolateral placement)	*P*
Number	29	29	
Age (range) (years)	62.2 ± 3.2 (56–70)	60.6 ± 5.4 (48–70)	ns
Gender (M/F)	23/6	26/3	
Body mass index (kg/m^2)	25.5 ± 3.8	25.7 ± 3.6	ns
Panel-reactive antibody (%)			
0	26	28	ns
10–30	3	1	ns
HLA match	1.4 ± 1.1	1.4 ± 0.9	ns
Time on dialysis (months)	36.3 ± 28.6	26.1 ± 19.4	ns
Immunosuppressive therapy			
ATG + CyA + MMF + Steroids	4	1	
Basiliximab + CyA + MMF + Steroids	13	1	
CyA + MMF + Steroids	6	–	
ATG + Sirolimus + MMF + Steroids	6	27	

All values are reported as mean ± SD.

Table 3. Results.

	Group I (bilateral placement)	Group II (monolateral placement)	*P*
Number	29	29	
Warm ischemia time (min)	29 ± 3	28 ± 4	ns
Cold ischemia time (h)			
First kidney	15.6 ± 3.1	15.6 ± 2.7	ns
Second kidney	18.2 ± 3.7	16.4 ± 2.7	0.052
Operating time (min)	351 ± 76	261 ± 31	0.0001
Blood transfusions			
Number of patients	16	8	ns
Transfusions (unit)	1.7 ± 0.7	1.5 ± 0.8	ns
Delayed graft function (DGF) (%)	52	10	0.001
Duration of DGF (days)	11.0 ± 7.9	6.0 ± 1.0	0.004
Infections (patients)	10	10	
Central venous line (CVL)	0	1	
Urinary tract	4	3	
Viral	2	0	
Other*	4	6	
Duration of CVL (days)	5.4 ± 4.1	5.6 ± 0.6	
Hospital stay (days)	24.6 ± 9.4	18.8 ± 7.6	0.007
Hospital stay without DGF (days)	19.5 ± 5.6	18.7 ± 7.8	ns
Acute rejection (%)	17	17	ns
Creatinine levels (μmol/l)			
At discharge	187.2 ± 96.4†	139.4 ± 71.9	
3 months	142.3 ± 49.5†	112.5 ± 25.6	
6 months	142.4 ± 44.8†	120.6 ± 42.2	
1 year	132.2 ± 47.3†	119.7 ± 35.7	
Follow-up (months)	51 ± 19	15 ± 7	
Patients with follow-up ≥1 year	28	18	
Actuarial 1-year patient survival (%)	100	100	ns
Actuarial 1-year graft survival (%)	93	96	ns

All values are reported as mean ± SD.
*Oral herpes simplex, preservation liquid positivity or unknown causes.
†The patient who lost one kidney in group I (due to ureteral necrosis) was excluded.

The causes of graft loss in group I were primary non-function in one case (an 85-year-old donor) and chronic rejection in two cases, 11 and 18 months after transplantation (the latter patient had been obliged to suspend immunosuppressive therapy due to Kaposi sarcoma). In group II, one graft loss was due to thrombosis of both

renal veins on postoperative day 3 in a patient heterozygotic for a factor V gene mutation (FV Leiden/FV506Q).

Mean operating times were 351 ± 76 and 261 ± 31 min ($P = 0.0001$) in groups I and II, respectively. There were eight surgical complications in group I: two cases of wound dehiscence were managed by secondary-intention wound treatment; one ureteral necrosis revealed by a urinary fistula required the removal of one kidney 10 days after transplantation; one urinary fistula in another patient on postoperative day 2 required re-anastomosis of the ureter with a double J stent and four small lymphoceles, which did not require surgical treatment. There were seven surgical complications in group II: two wound infections treated by surgical debridement and antibiotic therapy with surgical reclosure; one lymphocele treated laparoscopically with intraperitoneal drainage and two more small lymphoceles, which were not treated; one renal vein thrombosis (RVT) of both kidneys; and one lower limb edema on the transplant side, which resolved spontaneously in 10 days.

DGF was recorded in 15 (52%) patients in group I and three (10%) patients in group II, lasting 11.0 ± 7.9 and 6.0 ± 1.0 days ($P = 0.004$), respectively. The incidence of acute rejection within the first 6 months after transplantation was 17% in each group. No steroid-resistant acute rejection was observed in group I, whereas there were two cases in group II.

The mean usage of CVL and episodes of infection are given in Table 3.

The hospital stay after transplantation was 24.6 ± 9.4 for group I and 18.8 ± 7.6 days ($P = 0.007$) for group II. Serum creatinine levels are given in Table 3.

Discussion

Several studies have already reported the outcome of DKT, with very satisfactory results in terms of renal function [8,16–18]. By comparison with single kidney transplantation, DKT nonetheless carries a potentially higher risk of surgical complications for older recipients owing to the longer operating time and two-fold risk relating to the double vascular and urological anastomoses. Monolateral DKT was first described by Masson and Hefty [13]. Our technique differs from theirs in at least three main respects: first, we extend the right renal vein by incorporating the segment of IVC [15]; second, we use the external iliac vein for venous anastomosis instead of the IVC (this enables us to make a normal Gibson incision and reduce the retroperitoneal dissection); third, we perform two separate ureteral anastomoses.

This is the first report to compare bilateral and monolateral DKT procedures. Using the monolateral procedure, we observed a significant reduction in operating time and in the cold ischemia time (CIT) for the second kidney. A longer CIT is known to have a deleterious effect on organ function in the short and long term [19,20], and this seems to be even more important when kidneys come from marginal donors [19]. Another finding to consider is that monolateral DKT did not coincide with a higher surgical complication rate.

The most severe surgical complication reported in our series was RVT, observed in both the monolaterally placed kidneys (~2% overall). The incidence of RVT in kidney transplantation ranges from 0.5% to 4% [21]. Although the causes most often emphasized are technical errors in the anastomosis or partial iliac vein obstruction due to compression by hematoma or lymphocele, the cause remains unexplained in a large proportion of cases [22]. A review of the literature confirmed much the same incidence of RVT in DKT too [23]. The incidence of RVT also seems similar for mono- and bi-lateral DKT techniques [12,24,25], although an excessive mismatch between two monolaterally placed kidneys and the iliac fossa may lead to renal vein compression and consequent RVT. In our monolateral case of RVT, we discovered afterwards that the patient was heterozygous for a factor V gene mutation (FV Leiden/FV506Q) – a condition leading to a four-fold higher risk of primary allograft venous thrombosis in kidney transplantation [26].

Urological complications are another important issue soon after kidney transplantation. The conjoined and separate extravesical ureteroneocystostomy techniques (Lich-Gregoir) are used by different researchers with no clear differences as regards ureteral complication rate [25,27]. One of our urinary fistulas was due to a ureteral necrosis that remains a rather frequent complication (from 2% to 5% in the literature [28,29]). In marginal donors in particular, where ureteral micro-vascularization may be compromised, special care must be taken to preserve the hilar fat and peri-ureteral tissue, and the lower polar artery during dissection [21]. This is most important in the monolateral procedure because of the need for a longer ureter for the superiorly positioned kidney. Positioning a ureteral double J stent [30] and delaying the removal of the vesical catheter can help to reduce the risk of ureteral complications.

The third most common complication observed in our series was wound infection or dehiscence. Studies have demonstrated the effect of immunosuppressive therapy on wound complications in kidney recipients [31,32]. Humar et al. [31] demonstrated a significantly higher rate of fascial dehiscence using MMF versus azathioprine. Sirolimus further increases the wound complication rate, as reported in a match-paired pilot study [32]. We observed no such increase in wound complication rate in group II despite the majority of the patients being treated with

sirolimus-based therapy – so a monolateral rather than a bilateral access may be a favorable condition when a calcineurin-inhibitor (CNI)-free, sirolimus-based immunosuppression is adopted.

The significant difference in hospital stay between our two groups could be explained by the lower incidence of DGF in group II due to the more extensive use of ATG induction [33,34] and a CNI-free immunosuppressive therapy. On the other hand, as Knight et al. showed [35], the use of sirolimus in 27 of 29 patients in group II did not seem to increase the incidence of DGF or delay renal function recovery, as claimed by some authors [36]. Besides, the longer hospital stay in group I was not caused by a higher incidence of infectious episodes, which proved similar in the two groups in our study.

In conclusion, this uncontrolled, retrospective study has shown that the monolateral placement of both kidneys in DKT offers the advantage of a single incision with less surgical trauma and a shorter operating time, keeping the contralateral iliac fossa available for further transplantation procedures, with no increase in the surgical complication rate.

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