PAPER

Excellent Outcome in Recipients of Dual Kidney Transplants

A Report of the First 50 Dual Kidney Transplants at Stanford University

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Hypothesis: Recipients of dual kidney transplants from older expanded criteria donors (ECDs) have outcomes similar to recipients of single kidneys from younger donors. Dual transplantation is the use of both adult donor kidneys into a single adult recipient.

Design: Donor and recipient variables were entered into a database. Analysis was performed in a retrospective fashion. The unpaired *t* test and χ^2 test were used as appropriate.

Setting: A university teaching hospital.

Patients: All adult recipients of cadaveric kidney-only transplants from adult donors between November 1991 and January 1999. Patients were grouped based on whether they received a dual or single transplant and whether the donor was an ECD. The control group of patients received non-ECD cadaveric kidneys.

Results: Donors for recipients of dual kidneys were older and had a lower creatinine clearance on hospital admission than recipients of single control kidneys. Recipients of dual transplants were older, had fewer rejections, and had similar 3-month and 1-year serum creatinine levels vs controls. Predictors of an elevated serum creatinine level or graft loss at 3 months in recipients of ECD dual and single transplants included kidneys from donors with unstable preprocurement renal function, and recipients who developed delayed graft function.

Conclusion: Recipients of dual kidney transplants from ECDs have excellent outcomes similar to recipients of single control kidneys.

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ANY NOVEL technique to increase use of available organs for donation should be pursued aggressively, owing to the extreme disparity between available donors and patients in need of transplants. Dual kidney transplantation, the transplantation of 2 expanded criteria donor (ECD) adult kidneys into a single recipient, was developed to increase the use of kidneys from older donors.[1,2] Selection criteria that have placed kidneys into the ECD category include donor age, donor instability, and a biopsy specimen from the donor kidney that demonstrates adverse histology. Some authors have argued that the total nephron mass is important in the outcome of the transplantation.[3] Therefore, older donors or donors with longstanding hypertension presumably would not have sufficient functioning nephron mass and this would portend transplantation failure when single cadaveric renal transplantation (CRT) is performed; previously, these kidneys were discarded. Reports of dual kidney transplants have described similar outcomes in the recipients of dual transplants vs recipients of single transplants from younger donors.[4,5] In a preliminary report, we compared outcome in 15 recipients of dual CRTs vs recipients of single ECD kidneys.[4] We identified 3 factors that affect early function: donor creatinine clearance on hospital admission, donor age of 59 years or older, and cold storage time longer than 24 hours. In this report, we review our single-center experience in 50 recipients of dual transplants and compare outcomes with recipients of single kidneys. An extensive analysis is also made of outcome measures in recipients of dual vs single ECD kidneys based on early function.

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RESULTS

DONOR CHARACTERISTICS

Donors for recipients of dual ECD kidneys (n = 50) had kidneys that were significantly older than single control (n = 217) or single ECD (n = 73) kidneys (58 ± 15 vs

PATIENTS AND METHODS

Between November 1991 and January 1999, there were 340 recipients of adult cadaveric kidney-only transplants at our center, excluding recipients of pediatric en bloc transplants. We compared outcomes in recipients of dual ECD kidneys with single younger kidneys (control) and single ECD kidneys. The ECD kidneys were those that were refused by all other local transplantation centers owing to a history of hypertension, donor instability, donor age, pretransplantation biopsy result, or a combination of these factors. When the donor age was 60 years or older and the calculated admission creatinine clearance was 1.50 mL/s (90 mL/min) or less, the kidneys were usually transplanted as a dual transplant. The admission creatinine clearance was calculated using the Cockcroft-Gault equation as previously described.[6] Other donor criteria for our dual transplants included severe donor instability, a long history of hypertension, or marked elevation in donor creatinine level after hospital admission. Donors of single ECD kidneys frequently had a history of hypertension, diabetes, or high terminal creatinine clearance. The technique for dual kidney transplantation has been previously described; briefly, the right and left kidneys were placed into the right and left iliac fossa, respectively, via a midline extraperitoneal approach.[5] In 3 instances, when both donor kidneys were small and there was minimal aortic atherosclerosis, the kidneys were transplanted en bloc using the donor aorta and vena cava for vascular conduits. Every effort was made to shorten the cold storage time of the dual kidney transplants. We rarely use procurement biopsies in the decision to accept or decline kidneys for transplantation, preferring to use functional parameters such as change in serum creatinine levels, blood pressure stability, and urine output. Frequently, biopsy specimens are obtained near the capsule. In older donors, areas near the capsule are more likely to be ischemic, therefore misrepresenting the amount of glomerular sclerosis. The immunosuppressive strategies for the 3 different cohorts were similar throughout the study period. In general, cyclosporine-based triple therapy was used, which included cyclosporine emulsion after July 1995, azathioprine (which was replaced in July 1995 by mycophenolate mofetil), and prednisolone. We maintained our patients' cyclosporine levels between 350 and 450 ng/mL by whole-blood TDX for the first 6 months after transplantation and lowered the levels to between 150 and 250 ng/mL by the first year. Prednisolone is tapered to 10 mg by 1 month after transplantation. The mycophenolate dose was adjusted from 1 g twice daily based on gastrointestinal and hematologic parameters. Induction therapy, with either OKT-3 or an interleukin 2 inhibitor, was used for sensitized patients (Panel reactive antibody >30%), retransplantations, or African American recipients. We compared 16 donor and 25 outcome variables among the various groups. Donor variables included age, hemodynamics, urine output, history of hypertension or diabetes, admission, peak, and final creatinine levels, creatinine clearance, and biopsy results. Recipient and outcome variables included recipient age, human leukocyte antigen match, cold storage time, preoperative serum creatinine level, creatinine level at 1 week and 1, 3, 12, and 24 months, best creatinine level, length of hospital stay, readmissions, number of rejections, incidence of infections, incidence of complications, peak and transplant Panel reactive antibody, donor-recipient weight ratio, incidence of delayed graft function, and graft loss. Data were entered into a relational database. A multivariate analysis, unpaired *t* test, or χ^2 test was performed accordingly (all data are presented as mean ± SD). Significance was defined as differences with $P<.05$.

Table 1. Donor Characteristics for Recipients of Dual Renal Transplants (n = 50) vs Recipients of Single Control (n = 217) and Single ECD (n = 73) Kidneys*

	Dual	Control Single	ECD Single	*P*
Age, y	55.8 ± 14.7[1,2]	38.5 ± 16.5[1]	43.2 ± 16.2[2]	<.001
History of hypertension, %	42	25	30	NS
Lowest systolic blood pressure, mm Hg	81 ± 18	79 ± 18	77 ± 18	NS
Lowest recorded urine output, mL/h	33 ± 24[1]	76 ± 91[1]	65 ± 121	.002
Highest recorded urine output, mL/h	609 ± 318[1]	784 ± 50[1]	711 ± 443	.03
Lowest recorded 4-h urine output, mL	312 ± 189[1]	547 ± 489[1,2]	353 ± 229[2]	.003
Admission serum creatinine level, μmol/L (mg/dL)	79.5 ± 26.5 (0.9 ± 0.3)[1]	88.4 ± 26.5 (1.0 ± 0.3)[2]	97.2 ± 35.4 (1.1 ± 0.4)[1,2]	.04
Admission creatinine clearance rate, mL/s (mL/min)	1.38 ± 0.43 (83 ± 26)[1,2]	1.77 ± 0.73 (106 ± 44)[1]	1.63 ± 0.48 (98 ± 29)[2]	.007
Peak serum creatinine level, μmol/L (mg/dL)	123.8 ± 70.7 (1.4 ± 0.8)	114.9 ± 44.2 (1.3 ± 0.5)[1]	132.6 ± 53.0 (1.5 ± 0.6)[1]	.009
Final serum creatinine level, μmol/L (mg/dL)	106.1 ± 61.9 (1.2 ± 0.7)	88.4 ± 35.4 (1.0 ± 0.4)[1]	106.1 ± 44.2 (1.2 ± 0.5)[1]	.009
% GS on biopsy	11 ± 13	5 ± 8	7 ± 11	NS

**Data are presented as mean ± SD unless otherwise indicated. ECD indicates expanded criteria donor; NS, not significant; and GS, glomerular sclerosis. Superscript numbers denote groups compared; groups were compared using the unpaired t test or χ^2 test where appropriate.*

38 ± 17 and 43 ± 16, respectively, $P<.001$) (**Table 1**). Additionally, the donor admission creatinine clearance was lower in recipients of dual ECD kidneys vs single control and single ECD kidneys (1.38 ± 0.43 mL/s [83 ± 26 mL/min] vs 1.77 ± 0.73 mL/s [106 ± 44 mL/min] and 1.63 ± 0.48 mL/s [98 ± 29 mL/min], respectively, $P<.05$). Significant differences were also seen in urine output parameters. There were no significant differences in the percentage of glomerular sclerosis on biopsy between the groups (8% ± 10%, 6% ± 10%, and 7% ± 11% for dual vs control vs single ECD, respectively), although we only had data on approximately 15% of the cases in each group.

Table 2. Recipient Characteristics in Recipients of 50 Dual Renal Transplants Compared With Recipients of Single Kidneys*

	Dual	Control Single	ECD Single	*P*
Age, y	57 ± 11[1,2]	46 ± 12[1]	50 ± 12[2]	<.001
Wait time, d	450 ± 222[1]	615 ± 555	567 ± 285[1]	.03
HLA match	0.9 ± 1.0[1]	1.5 ± 1.7[1,2]	0.9 ± 0.9[2]	<.01
Cold storage, h	18 ± 8[1]	20 ± 8[1]	21 ± 8	.04
Delayed graft function, %†	26	30	39	NS
LOS, d	9.5 ± 8.2	8.0 ± 5.5	7.6 ± 3.9	NS
Serum creatinine level at 1 mo, µmol/L (mg/dL)	168.0 ± 141.4 (1.9 ± 1.6)	185.6 ± 132.6 (2.1 ± 1.5)	203.3 ± 141.4 (2.3 ± 1.6)	NS
Serum creatinine level at 3 mo, µmol/L (mg/dL)	141.4 ± 70.7 (1.6 ± 0.8)[1]	168.0 ± 123.8 (1.9 ± 1.4)	176.8 ± 106.1 (2.0 ± 1.2)[1]	.04
Serum creatinine level at 12 mo, µmol/L (mg/dL)	150.3 ± 53.0 (1.7 ± 0.6)	176.8 ± 168.0 (2.0 ± 1.9)	159.1 ± 70.7 (1.8 ± 0.8)	NS
Serum creatinine level at 24 mo, µmol/L (mg/dL)	141.4 ± 26.5 (1.6 ± 0.3)	150.3 ± 53.0 (1.7 ± 0.6)	150.3 ± 88.4 (1.7 ± 1.0)	NS
No. of readmissions	0.5 ± 1.0[1]	1.1 ± 1.6[1,2]	0.6 ± 1.0[2]	<.03
No. of complications	0.4 ± 0.8[1]	0.2 ± 0.5[1]	0.4 ± 0.5	<.05
No. of rejections	0.2 ± 0.5[1,2]	0.7 ± 0.9[1]	0.4 ± 0.8[2]	<.05
Graft loss, %‡	10	20	18	NS
Patient/graft survival at 1 y, %	96/86	96/87	99/86	NS
Patient/graft survival at 2 y, %	86/76	93/82	96/81	NS
Censored graft survival at 2 y, %§	85	86	84	NS

**Data are presented as mean ± SD unless otherwise indicated. ECD indicates expanded criteria donor; NS, not significant; and LOS, length of stay. Superscript numbers denote groups compared; groups were compared using the unpaired t test or χ^2 test where appropriate.*

†*Defined as dialysis within the first week after transplantation.*

‡*Defined as permanent return to dialysis during the study period.*

§*Censored for death (patients died with a functioning graft).*

RECIPIENT CHARACTERISTICS

Recipients of dual ECD kidneys were significantly older than recipients of single control or single ECD kidneys (57 ± 11 vs 50 ± 12, vs 46 ± 12 years, $P<.001$) (**Table 2**). The human leukocyte antigen match was significantly better in recipients of single control vs dual or single ECD kidneys (1.5 ± 1.7, 0.9 ± 1.0, and 0.9 ± 1.0, respectively, $P<.01$). The cold storage times were the shortest in recipients of dual kidneys ($P = .04$).

RECIPIENT OUTCOMES

In these groups of patients, there was no significant difference in delayed graft function (Table 2). Recipient creatinine levels were similar among the 3 groups of patients for up to 2 years. The length of hospital stay was not different among the groups. Interestingly, the mean number of rejections per patient was significantly lower in recipients of dual vs single kidneys. There was no difference in the number of technical complications, but recipients of dual kidneys had significantly more overall complications vs recipients of single control kidneys (0.4 ± 0.8 vs 0.21 ± 0.5, $P = .04$). The number of complications were not different in recipients of dual vs single ECD kidneys. There were no differences in donor-recipient weight ratio between the 3 groups (1.1 ± 0.3, 1.1 ± 0.4, and 1.1 ± 0.4) for the dual, control, and single ECD groups, respectively.

EVALUATION OF OUTCOME IN THE ECD KIDNEYS

We divided the recipients of ECD kidneys into 4 groups based on transplant type and outcome at 3 months; recipients of dual CRT with a serum creatinine level of less than 221 µmol/L (2.5 mg/dL) at 3 months (group 1, n = 29), recipients of dual CRT with a serum creatinine level of 221 µmol/L (2.5 mg/dL) or more or graft loss at 3 months (group 2, n = 11), recipients of single ECD CRT with a serum creatinine level of less than 221 µmol/L (2.5 mg/dL) at 3 months (group 3, n = 48), and recipients of single ECD with a serum creatinine level of 221 µmol/L (2.5 mg/dL) or more or graft loss at 3 months (group 4, n = 20) (**Table 3**). The remaining recipients of ECD kidneys had not reached the 3-month period at the time of this comparison. The differences in donor age between groups 3 and 4 (42 ± 16 years vs 49 ± 16 years) approached but did not reach statistical significance ($P = .07$). Donor postadmission blood pressure parameters were not different among the 4 groups. Urine output parameters were the best in group 3 and the worst in group 4 ($P = .04$). These data support the concept of using urine output parameters as an indication of donor function. The admission creatinine clearance was highest in group 3 and similar in groups 1 and 2. Group 4 had an admission creatinine clearance that was intermediate, but was at our cutoff level for use as a dual donor if the donor was aged 60 years or older. The creatinine clearance measured from the donors' peak creatinine level was significantly lower in group 4 vs group 3, but not different than group 1 or 2. This suggests that when a donor's serum creatinine level rises abruptly, regardless of age, reconsideration of the kidneys for use as a dual transplant should occur. The donor/recipient HLA match was the best in group 2 and similar in the other 3 groups. Cold storage time was not different among the 4 groups. Interestingly, delayed graft function (DGF) was an important determinant of 3-month outcome. Fifty percent of patients with either a dual or single ECD CRT (groups 2 and 4, respectively) who developed DGF subsequently had a creatinine level of 221 µmol/L (2.5 mg/dL) or higher or graft loss at 3 months. In group 1, only 13% had DGF. This strongly advocates for efforts to prevent DGF, particularly in recipients of

Table 3. Donor and Recipient Characteristics in Recipients of Dual and Single Expanded Criteria Donor Kidneys*

	Group				
	1	2	3	4	*P*
Donor age, y	57 ± 14[1]	53 ± 17[2]	42 ± 16[1,2]	49 ± 16	<.04
Donor admission creatinine clearance, mL/s (mL/min)	1.40 ± 0.40 (84 ± 24)[1]	137 ± 0.58 (82 ± 35)	1.70 ± 0.50 (102 ± 30)[1]	1.50 ± 0.45 (90 ± 27)	.01
Donor peak creatinine clearance, mL/s (mL/min)	1.00 ± 0.33 (60 ± 20)[1]	1.15 ± 0.57 (69 ± 34)	1.35 ± 0.47 (81 ± 28)[1,2]	1.10 ± 0.38 (66 ± 23)[2]	<.03
Donor lowest urine output, mL/h	38 ± 25[1]	39 ± 15[2]	69 ± 107	22 ± 23[1,2]	<.04
Recipient age, y	56 ± 12[1]	60 ± 9[2]	50 ± 11[1,2]	51 ± 13	<.03
HLA match	0.7 ± 0.9[1]	1.6 ± 1.0[1,2]	0.9 ± 0.9[2]	0.8 ± 1.1	<.03
Cold storage, h	19 ± 8[1]	22 ± 7[1]	21 ± 8	20 ± 8	NS
DGF, %	14[1,2]	55[1]	34	50[2]	.02
Serum creatinine level at 6 mo, µmol/L (mg/dL)	114.9 ± 44.2 (1.3 ± 0.5)[1-3]	274.0 ± 79.56 (3.1 ± 0.9)[1,4]	141.4 ± 44.2 (1.6 ± 0.5)[2,4,5]	291.7 ± 229.84 (3.3 ± 2.6)[3,5]	<.04
Serum creatinine level at 12 mo, µmol/L (mg/dL)	132.6 ± 44.2 (1.5 ± 0.5)[1]	212.2 ± 35.4 (2.4 ± 0.4)[1]	159.1 ± 70.7 (1.8 ± 0.8)	168.0 ± 70.7 (1.9 ± 0.8)	<.005
No. of rejections	0.2 ± 0.5[1,2]	0.3 ± 0.7[1]	0.4 ± 0.7[2]	0.4 ± 0.9	NS
Graft loss, %†	0[1,2]	45[1,3]	7[3,4]	40[2,4]	<.001

*Data are presented as mean ± SD unless otherwise indicated. DGF indicates delayed graft function; NS, not significant. Recipients were grouped based on outcome at 3 months. Dual recipients with a serum creatinine level less than 221 µmol/L (<2.5 mg/dL) (group 1 [n = 29]) were compared with dual recipients with a serum creatinine level of 221 µmol/L or higher (≥2.5 mg/dL) or graft loss at 3 months (group 2 [n = 11]), single kidney recipients with a serum creatinine level of 221 µmol/L or higher (≥2.5 mg/dL) or graft loss at 3 months (group 4 [n = 20]). Superscript numbers denote groups compared; groups were compared using the unpaired *t* test or χ^2 test where appropriate.

†For purposes of this table, graft loss refers to loss during any time of the study period and not just during the first 3 months after transplantation.

dual kidney transplants from older donors. There were no significant differences in mean rejection episodes within the groups.

COMMENT

Since 1995, we have performed 50 dual transplantations using kidneys from older donors. We believe that the results have been excellent. The use of ECDs kidneys is not novel,[7,8] but understanding when and how to use the kidneys is important. We have generally used kidneys from older donors with a creatinine clearance lower than 1.5 mL/s (90 mL/min) as a dual transplant. However, in selected settings, eg, when the donor's terminal creatinine level is higher than 265 µmol/L (3 mg/dL), we have used the kidneys from younger donors as a dual transplant. Contrarily, when we have had otherwise healthy and vigorous donors older than 60 years, we have selectively used the kidneys singly. In general, these decisions have resulted in excellent outcome.

This study reaffirms our preliminary observations that recipients of dual CRTs from ECDs have outcomes that are identical to recipients of younger single kidneys.[4,5] Serum creatinine levels up to 2 years after transplantation are identical between these groups. The 2-year patient survival rate is 7% lower in the dual recipients and the graft survival rate is similarly 6% lower. When censored for death, the 2-year graft survival is identical between the groups. We had previously seen a decrease in DGF after dual transplantation, but as our experience has grown, this difference is no longer apparent.

The evaluation of outcome in our ECD dual vs single recipients yielded some interesting data. As donor age approaches 50 years in ECD kidneys, consideration should be given to the use of the kidneys as a dual transplant. The postadmission hospital course of the donor is also important in this consideration. Recipients of single kidneys from donors with a lower peak creatinine clearance and low urine outputs were more likely to have worse outcome at 3 months. Some authors believe that DGF does not predict long-term outcome except when associated with acute rejection, while others believe these events are independent predictors of worse outcome.[9-11] In our study, DGF was a strong indicator of decreased function or graft loss in dual and single CRTs from ECDs. These patients subsequently had significantly more graft loss during the study period. Taken together, these data suggest that the donor function after admission probably predicts early posttransplantation function in ECD kidneys. Additionally, the early posttransplantation function predicts 3-month outcome in these same patients. Long-term outcome studies will be needed in recipients of ECD dual and single transplants to draw final conclusions from these data. We had previously reported in a preliminary study that a donor age of 59 years or older, creatinine clearance on admission less than 1.5 mL/s (90 mL/min), and cold storage time longer than 24 hours influenced early outcome when using ECD kidneys.[4] The use of dual transplants seems to alleviate this problem except in the setting of delayed graft function. Rejection did not seem to play a role in our study. Interestingly, although at 3 months recipients of ECD kidneys had higher serum creatinine levels (groups 2 and 4), by 6 months, the recipients who had not suffered graft loss had serum creatinine levels that were similar to those recipients with better function at 3 months, particularly patients in group 4. This may suggest a longer recovery period for ECD kidneys.

Analysis of our overall outcome in recipients of dual CRTs demonstrates excellent outcome. There are situations in which outcome can be improved and we are continually analyzing our data and that of others to help understand the best use of these ECD kidneys. It is unclear why dual recipients have fewer rejection episodes but it may be that as experience grows, these differences will disappear. Although patients in the control group include 2 slightly different immunosuppressive strategies, the patients in the dual and single ECD CRT groups received tranplants during identical periods and the dual recipients still had fewer rejection episodes. It is beyond the scope of this type of evaluation to draw conclusions from these data. Although we attempt to match our dual donors with the recipients for size and age, data analysis shows no difference between the groups in this regard. We will continue these efforts, however, because we believe a large size mismatch between the donor and the dual recipient would be unwise.

In conclusion, excellent outcome can be achieved by the selective use of dual CRTs from older ECD donors. Analysis of 3-month outcome supports the concept of reducing DGF to optimize favorable results in recipients of both single and dual ECD kidneys. We believe efforts should be continued to aggressively use aged donors for dual CRTs in an effort to ameliorate the disparity between donors and patients awaiting transplantation.

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DISCUSSION

Susan Orloff, MD, Portland, Ore: Dr Lu, I enjoyed your presentation, and I would like to commend the authors for an excellent manuscript on the use of a novel approach to expanding the pool of donor organs in an era of increased need. As the disparity between the number of donor organs available and the number of recipients awaiting transplantation increases, alternative, somewhat unconventional approaches to traditional donor selection must be proposed. The authors report on the use of dual kidneys in 50 recipients. Two expanded criteria donor adult kidneys are transplanted into a single recipient. They implemented this approach back in 1995, previously calling these kidneys "the kidneys that nobody wanted," because they were refused by all other local transplant centers owing to donor history of hypertension, donor instability, donor age, which correlates with suboptimal nephron mass, and biopsy-proven adverse histology, or a combination of these factors. These kidneys would otherwise be destined for discard. In this study when the donor age was greater than 60 years and the calculated creatinine clearance was 90 cc per minute or less, these kidneys were usually transplanted as dual transplants into a single recipient. They compared the outcomes between younger control cadaveric renal transplants, dual extended criteria donor kidneys, and single extended criteria donor kidneys. The recipients of the dual kidneys were significantly older than the recipients of the single control or single expanded criteria donor kidneys. They found no significant difference in delayed graft function between the control single transplants and the dual and single ECD kidney transplants. The serum creatinine levels and the graft survival at 2 years were similar among the 3 groups studied. These results are very exciting and encouraging. I would just like to ask the authors a few questions.

From your widespread experience with these marginal donors, if you had 2 characteristics that you could choose in the donor to predict short-term and long-term graft survival and function, what would these be? Also, you rarely biopsy the kidneys because you don't place much emphasis on percentage of glomerulosclerosis; however, others have shown that greater than 20% glomerulosclerosis results in up to 80% delayed graft function. I am wondering if you can comment on this. Also, the degree of glomerulosclerosis has been shown not to correlate with donor serum creatinine level. Therefore, would you advocate using biopsies in older donors with a history of hypertension to determine the extent of glomerulosclerosis and use this in your decision algorithm?

You reported in your manuscript that the recipients of dual kidneys had an increase in overall complications compared with control and ECD single kidney recipients. What were these complications and how did they affect graft function?

Have you done a cost analysis on the use of dual kidneys vs single kidneys, both looking at procurement costs, because the procurement potentially takes longer owing to the time to evaluate the less conventional donor, as well as the operative time for the recipeint, given that it takes longer to place 2 kidneys vs 1 in a single recipient?

How do you explain the lower rejection rate in the recipients of dual kidneys? One would think that you would have an increase in rejection rate in the setting of transplantation of 2 kidneys into 1 recipient because you are doubling the foreign alloantigen load. Instead, you experienced a decreased rejection rate compared to the single kidneys.

Did you look at the mode of donor death in your study? Terasaki et al have shown that kidneys from donors that are motor vehicle accident victims produce lower recipient discharge serum creatinine levels than those from patients who had cerebral vascular accidents such as stroke. Finally, I would just like to comment on the critical question regarding this study:

what is the long-term function and survival of these grafts, that is, what is the function and survival at 5 to 10 years?

This is a very important study in evolution and we must evaluate the 5-year and 10-year results to determine the true benefit of the use of expanded criteria donor kidneys. Until this data is available, other transplant centers are unlikely to join in the use of these expanded criteria donor kidneys. However, we await the long-term results of this study with both enthusiasm and optimism as Drs Dafoe, Alfrey, and colleagues help to pave the way in achieving the goal of expanding the donor pool in a time of serious and ever-increasing shortage.

David Tapper, MD, Seattle, Wash: At the University of Washington, our transplant group is also using dual kidneys to expand the donor pool, and I would ask whether the data from the groups that are following this for older donors will be so compelling that the transplanters will recommend that only dual kidneys be used from people older than age 60 years and that single kidneys be used only from donors younger than age 60 years. Do you believe that the histology and the function on these kidneys from donors older than age 60 years will be so compelling that transplanters will use only dual kidneys for donors older age 60 years and that only single organs will be placed if the donor is younger than age 60 years?

Thomas Berne, MD, Los Angeles, Calif: I believe that trauma and surgical critical care services must make every possible effort to assist our transplantation colleagues in identifying, maintaining, and delivering usable donor organs to them for transplantation. I think it is important to hear papers like this because what it says is that we should never judge which donor is an acceptable donor. We must always leave that to the procurement agencies and the transplant surgeons.

Thomas Russell, MD, San Francisco, Calif: I would like to know before you went into this study and showed that you could do this effectively, how did you get informed consent from these patients where you were transplanting kidneys that others had turned down?

Joseph D. Schmidt, MD, San Diego, Calif: As I am the only urological surgeon here at this meeting, I must ask a question related to the ureteral reimplantations. When transplanting 2 kidneys, one has an opportunity to vary the ureteral reimplantations. Can the authors comment on this: were they doing transvesical reimplants, for example, the Cohen or Leadbetter-Politano techniques, or any of the other types of intravesical procedures that generally are successful in preventing reflux in nontransplant patients, or were they using extravesical techniques common for transplanted single kidneys? Finally, please describe the complications related to the ureteral reimplantations.

Dr Dafoe: Using this technique we have increased the number of organs available for transplant by 15% in our program. The concept underlying is: not all kidneys are created equal; and one size does not fit all; rather, nephron dose should meet metabolic demand.

Dr Orloff asked what are our main criteria for determining when to use 2 kidneys instead of 1: primarily age, but more importantly creatinine clearance. We calculate creatinine clearance in the donor and we use that functional parameter. Currently, if it is over 90 mL per minute, then we will transplant them separately into 2 recipients. We don't know what the lower limit of acceptable clearance is, but it is probably somewhere around 60. So if the creatinine clearance is at 60 or less for the donor in both kidneys, we will discard those kidneys. If the creatinine clearance is between 60 and 90, we would use them as duals; and if it is greater than 90, we would use them singly.

You are correct, Dr Orloff, in saying that we do not rely on the biopsy the way other programs have. This primarily relates to our belief that a biopsy, as it is done by most transplant surgeons, an elliptical biopsy from the surface of the kidney, is misleading. Glomeruli sclerose from the outside in. So a surface biopsy overrepresents sclerosed glomeruli. We like to avoid the needle biopsy because of the risk of bleeding and fistulae. So we use a functional parameter rather than, what we argue, is a misleading morphological one.

Complications? Dr Schmidt also asked about this question. You would think with 2 kidneys being transplanted, the technical complications should be double in our dual recipients. But, in fact, we found no difference in complications in recipients of dual vs single ECD kidneys. The higher complication rate in the dual vs control singles were not technical complications and were most likely related to the older age of the dual recipients. When there were complications, they related to infection primarily, wounds and pneumonia, especially in these older patients. By the way, Dr Schmidt, our ureteroneocystostomy technique is the extravesical Lich type.

With regard to Dr Orloff's question about why did dual allograft recipients have decreased acute rejection rates, I think the explanation is that recipients of the dual kidneys were more elderly and we know that immuncompetence decreases with age. Despite a double antigen load, although we believe in antigen load, I don't think doubling it makes much difference; in other words, the rejection cascade is triggered and is not as dependent on the load of antigen or antigen-presenting cells delivering the antigen as other settings like small-bowel transplantation.

As far as the cause of donor death, fortunately because of air bags and tougher drunk driving laws and so forth, the profile of the donors has changed now from the young man on his motorcycle to the older patient who has had a stroke. So we have had a "graying" of our donor population that comes at a time of "graying" of our recipient population and people on dialysis. So there is some poetic justice, I think, in older donors giving kidneys to older recipients, sometimes in the form of dual grafts.

Long-term function is the real question. We don't know the answer. We have only been performing dual renal allografts for 3 years. Keep in mind the idea that some people need a Cadillac, some people need a Yugo. If you are driving from here to San Diego, a Yugo might do it. In other words, if you are over 65, you don't have as much time left, to put it bluntly. Whereas, if you are driving to Seattle, you might want the Cadillac. So we keep that analogy in mind regarding the age of the recipient. We do not have information on cost comparisons although we are charged a single procurement fee for the dual transplants.

Dr Tapper, thank you for your comments. I am glad to see that other programs such as the University of Washington are beginning to apply dual transplants. Should only dual allografts go in older recipients? Again, I think we should adhere to the concept of function vs metabolic demand, metabolic demand based on age and size primarily.

Dr Russell, the issue of informed consent is a thorny one. We initially explain dual allografting to the patients at the time of evaluation and again when we call them in for the transplant. We try to be very fair because clearly this approach isn't proven. We had about a 50% turndown rate. As our experience builds and we refer to data in our discussions with patients and their referring physicians, our rate of decline has gone down. But we do believe strongly that patients should be aware that this is an unproven approach and that is their "call."

One last point, if patients do accept the dual allograft approach, the payback is that they may get transplanted earlier.