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Survival Benefit of En bloc Transplantation of Small Pediatric Kidneys in Children

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Abstract

Background: En bloc transplantation of small pediatric kidneys in children may help expand the existing deceased donor pool; however, studies examining the long-term outcomes of en bloc transplantation in children are few.

Methods: We used the Scientific Registry of Transplant Recipients to identify 149 pediatric en bloc recipients transplanted from 10/1/1987-12/31/2017. We used propensity scores to match 148 en bloc with 581 non-en bloc deceased donor recipients (matching variables: transplant age, gender, race, pretransplant dialysis, transplant center and year). We evaluated patient and graft survival using Kaplan-Meier and Fleming-Harrington weighted log-rank test, and examined survival benefit of en bloc transplantation versus remaining on the waitinglist using the sequential Cox approach. We divided the study period into three 10-year intervals to assess the effect of era on outcomes.

Results: Compared with non-en bloc recipients, en bloc recipients had lower 1-year graft survival (78.9% vs. 88.9; p 0.007), however when stratified by transplant era, lower 1-year survival was only observed in the oldest era (1987-1997). En bloc recipients had superior 10-year patient

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(89.0% vs. 80.4%; p 0.04) and graft survival (51.6% vs. 39.9%; p 0.04) compared with non-en bloc recipients. After multivariate adjustment, en bloc transplantation was associated with superior patient survival compared with remaining on the waitinglist (aHR: 0.58; 95%CI: 0.36–0.95; p 0.03).

Conclusions: En bloc transplantation of small pediatric kidneys in children is associated with superior long-term patient and graft survival. The increased risk of 1-year graft loss among en bloc recipients only appeared in the oldest era.

Introduction

Kidney transplantation is the treatment of choice of children with end-stage renal disease.¹ Despite the pediatric priority for organ allocation, pediatric access to transplantation is limited by the widespread organ shortage. In 2017, the deceased donor waiting list included 1575 pediatric candidates of whom 20% had been waiting for 2-4 years and 15% for > 4 years.² This situation is dismal as prolonged periods of dialysis are associated with higher mortality, poor physical growth and inferior neurocognitive outcomes in children.³⁻⁶ The recent decline in living donations for children has further compounded the organ shortage urging us to seek nonstandardcriteria donors to expand the existing deceased donor pool.²

Due to the severe organ shortage, adult candidates have increasingly been receiving kidneys from small pediatric donors (< 5 years of age or < 20 kg in weight)⁷ Transplantation of small pediatric kidneys is performed either singly or en bloc. En bloc refers to transplantation of both kidneys into a single recipient and entails anastomosis of donor's aorta and IVC to recipient vessels.⁸ Despite concerns about surgical complications, vascular thrombosis and hyperfiltration-induced graft injury,⁹⁻¹¹ adult studies demonstrate comparable graft survival between en bloc transplanted small pediatric kidneys and standard deceased donor transplants.¹²⁻¹⁶ Despite the promising adult data, en bloc transplantation in pediatric candidates remains uncommon, and concerns about surgical and thrombotic complications persist due to their smaller size and developing anatomy.¹⁷ Existing data are insufficient to support en bloc transplantation in pediatric recipients.

The primary objective of this study was to examine long-term patient and graft survival among pediatric en bloc transplant recipients. We compared patient and graft survival between en bloc recipients and matched non-en bloc deceased donor recipients. We also examined patient survival associated with en bloc transplantation versus remaining on the waiting list for a non-en bloc deceased donor kidney. We also evaluated the effect of era of transplantation on transplant outcomes. We had hypothesized that en bloc and non-en bloc deceased donor kidney recipients would have similar patient and graft survival. We had also hypothesized that en bloc transplants would be associated with superior patient survival compared with remaining on the waiting list for a standard deceased donor kidney and not accepting en bloc kidneys. To our knowledge, this is the only study to evaluate survival benefit associated with en bloc transplantation versus remaining on the waiting list for a subsequent non-en bloc standard deceased donor offer. This is also the only study to report patient and graft survival beyond 5-years and to assess the effect of era on en bloc kidney transplantation outcomes.

Methods

Data source

We utilized data from the Scientific Registry of Transplant Recipients (SRTR) for this study.¹⁸ The SRTR data system includes data on all donors, waitlisted candidates, and transplant recipients in the United States, submitted by the members of the Organ Procurement and Transplantation Network (OPTN). The Health Resources and Services Administration (HRSA), US Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors¹⁹. The data that support the findings of this study are openly available in SRTR.

Small pediatric and en bloc donors

We defined small pediatric donors as donors who were ≤ 5 years of age or ≤ 20 kg in weight. The en bloc status of transplant was determined by using the following SRTR variable “Transplant Procedure Type”. Five en bloc recipients who did not meet the criteria for small pediatric donors were excluded from the analysis.

Study population

We identified all kidney transplant recipients, aged <18 years, who received en bloc transplantation of deceased donor small pediatric kidneys in the US between 10/1/1987 and 12/31/2017. To create a comparison group of standard deceased donor recipients with similar characteristics as the en bloc group, we calculated propensity scores for the 149 en bloc and 11,465 standard deceased donor recipients using a generalized additive logistic regression model. The transplant type (en bloc or standard deceased donor) was treated as the binary outcome and age at transplant, gender, race, pre-transplant dialysis, transplant center, and transplant year were treated as predictors (natural cubic spline terms were used for recipient age and transplant year). Panel reactive antibodies (PRA) were not included in the model due to a significant amount of missing data. Propensity scores represented each recipient's predicted probability of receiving en bloc transplant. After calculating propensity scores, we used 4:1 nearest-neighbor matching, with exact matching for transplant center, to identify up to four standard deceased donor transplant recipients for each en bloc recipient. Using this approach, we matched 148 of the 149 en bloc recipients with 581 standard deceased donor recipients.

Study variables

We compared the following donor characteristics between en bloc and matched non-en bloc recipients: donor age, gender, race, kidney donor profile index (KDPI), and donors' cause of death. We calculated KDPI for each donor to determine the risk of kidney failure for that donor compared with a reference donor.

We examined the following recipient characteristics: age at transplant, gender, race, pretransplant dialysis, cause of end-stage renal disease, blood type, number of HLA mismatches and cold-ischemia time.

For recipients who lost their graft or died, we examined the causes of graft loss or death.

Study Outcomes

Primary outcomes of interest were patient and graft survival. For patient survival, we followed recipients from the date of transplant to the earliest of the dates of death or end of SRTR follow up. For graft survival, we followed the recipients from the date of transplant to the earliest of the dates of graft loss, death, or the end of SRTR follow up.

To evaluate the survival benefit that a pediatric candidate would derive from accepting small pediatric kidneys transplanted en bloc versus remaining on the waiting list for non-en bloc offers and not accepting en bloc kidneys, we used sequential stratification or sequential Cox approach.²⁰⁻²² Our goal was to evaluate residual survival (survival after en bloc transplantation versus had they remained on the waiting list). For each of the 149 en bloc recipients we created a comparison group comprising all candidates, aged younger than 18 years, who were active on the waiting list on en bloc recipient's transplant date. We followed each en bloc recipient and respective comparison group from recipient's transplant date to the earliest of the dates of death or end of SRTR follow up. If a recipient in the comparison group had a subsequent deceased donor en bloc or a living donor transplant, follow up was censored at the transplant date. Follow up was not censored for subsequent deceased donor non-en bloc transplants. Each en bloc recipient with his/her respective comparison group was considered a separate "experiment" (also termed "stratum" or "landmark").

Statistical Analysis

We compared continuous and categorical variables between en bloc and matched deceased donor recipients using Chi square and Wilcoxon rank sum tests, respectively.

We compared patient, graft, and death-censored graft survival between en bloc and matched non-en bloc recipients using the Kaplan-Meier methods. Survival curves for graft survival and death-censored graft survival crossed and the proportional hazard assumption was violated for these outcomes (tests for proportional hazard: patient survival, p value 0.89; graft survival, p value 0.0003; death-censored graft survival, p value 0.0006). Since the ordinary log-rank test does not perform well in this situation, we used the Fleming-Harrington weighted log-rank test with $\rho = 0$ and $\lambda = 1$, which places greater emphasis on later differences in survival.²³ An additional test (with complementary log-log transformation) comparing survival at 1, 3, 5, 10, 15 and 20 years is also presented.²⁴

To evaluate the survival benefit of accepting small pediatric en bloc kidneys compared with remaining on the waiting list for non-en bloc offers, we used the Cox regression analysis stratified on each experiment and adjusted for age, gender, race, pretransplant dialysis, blood type, and transplant center, with a natural cubic spline term for age. Since wait listed candidates may have been used in more than one comparison group, we used robust sandwich variance estimators.

To examine the effect of era of transplantation on transplant outcomes, we divided the study period into three 10-year intervals (era 1:1987-1997; era 2: 1998-2007; era 3: 2008-2017) and performed stratified analysis for patient and graft survival.

Analyses were performed using R version 3.5.2 (R Foundation for Statistical Computing, Vienna, Austria).²⁵ A two-sided p value of < 0.05 was regarded as statistically significant. The institutional review board (IRB) of the University of Minnesota approved this study.

Results

En bloc transplantation constituted 1.3% (149/11,614) of all pediatric deceased donor kidney transplants in the US between 1987 and 2017.

Donor characteristics

Table 1 compares the baseline characteristics of en bloc donors versus matched deceased donors. Compared with matched deceased donors, en bloc donors were more likely to be black (27.0% vs. 15.7%). En bloc recipients were also more likely to die from anoxia (38.5% vs. 17.0%). The median KDPI score was substantially higher for en bloc compared with non-en bloc donors (72.5% vs. 21.5%).

Recipient characteristics

Table 2 demonstrates that propensity matching was successful with similar mean age at transplant, gender and race distribution, prevalence of pre-transplant dialysis, and blood group distribution among en bloc and non-en bloc recipients. The number of HLA mismatches and underlying causes of end-stage renal disease were also similar between the two groups. We found no difference in the incidence of delayed graft function between en bloc and non-en bloc deceased donor recipients (15.5% vs. 11.7%, p 0.26).

Transplant outcomes

Graft survival

After matching for covariates, the long-term overall graft survival and death-censored graft survival were significantly higher in en bloc recipients compared with matched non-en bloc recipients (p < 0.01) (figures 1 and 2).

For the overall graft survival, en bloc recipients had lower 1-year survival (78.9% vs. 88.9; p 0.007), similar 5-year survival (66.4% vs. 64.8%; p 0.72), and higher 10 (51.6% vs. 39.9%; p 0.04) and 20-year survival (25.4% vs. 11.0%; p 0.04) compared with non-en bloc recipients (figure 1).

Correspondingly, death-censored graft survival was lower at 1-year (79.5% vs. 90.4%; p 0.002), similar at 5-year (68.4% vs. 67.5%; p 0.85), and higher at 10 years (54.1% vs. 44.1%; p 0.09) for en bloc recipients (figure 2).

Causes of graft loss

Graft loss due to thrombosis was higher in en bloc recipients (11.9% vs. 3.4%) while graft loss due to chronic rejection was higher in non-en bloc recipients (36.0% vs. 22.4%) (p 0.07) (table 3). Of all patients who lost their graft in the first year, graft loss due to thrombosis was 23.3% for en bloc versus 14.8% for matched non-en bloc recipients (p 0.2).

Causes of graft loss by recipients' age for en bloc recipients

Table 4 presents the causes of graft loss for en bloc recipients by age at transplant. While graft loss due to thrombosis appeared to be higher among recipients < 5 years (9.1% vs. 5.7%), we found no significant difference in the age at transplant for en bloc recipients who developed graft thrombosis (median age: 13.0 years, IQR: 8.8 to 14 years) versus those who did not (median age: 13.1 years, IQR: 8.4 – 16.2 years) (p 0.43).

Patient Survival

As illustrated in figure 3, en bloc recipients had a trend towards better long-term patient survival compared with matched non-en bloc recipients. 1- and 5-year patient survival were similar, but 10-year patient survival was higher for en bloc recipients (89.0% vs. 80.4%; p 0.04).

Causes of death

As shown in table 3, we found no differences in the causes of death between the two groups.

En bloc transplantation versus remaining on the waiting list

After multivariate adjustment, en bloc transplantation of small pediatric kidneys was associated with superior patient survival compared with remaining on the waiting list and not accepting en bloc kidneys (adjusted hazard ratio (aHR): 0.58; 95% CI: 0.36 – 0.95; p 0.03).

Graft survival by era of transplantation

Of the 148 en bloc transplants, 49, 53, and 46 transplants were performed in era 1 (1987-1997), era 2 (1998-2007) and era 3 (2008-2017), respectively.

As illustrated in figure 4a, en bloc recipients transplanted in era 1 had a significantly lower 1-year graft survival compared with non-en bloc recipients transplanted in the same era (63.0% vs. 84.5%; p 0.005). However, 20-year graft survival was similar between en bloc and non-en bloc recipients transplanted in era 1 (14.9% vs. 9.0%; p 0.35).

For patients transplanted in era 2, there was no significant difference in 1-year graft survival (83.0% vs. 89.1%; p 0.28), but 15-year graft survival was significantly higher in en bloc recipients (50.8% vs. 21.8%; p 0.002).

For transplants performed in era 3, we found no difference in 1-year (p 0.73) or 5-year graft survival between en bloc and non-en bloc recipients. Longer-term data were not available for era 3 due to inadequate follow up time.

Patient survival by era

As shown in figure 4b, there was no difference in 1-year (96.7% vs. 89.2%; p 0.1) or 20-year (38.4% vs. 36.3%; p 0.86) patient survival between en bloc and non-en bloc deceased donor recipients who received their graft in era 1.

For patients transplanted in era 2, 1-year patient survival was similar (97.3 vs. 98.1; p 0.72), but 15-year patient survival was significantly higher in en bloc recipients (87.0% vs. 60.3%; p 0.006).

We found no difference in patient survival between en bloc and non en-bloc recipients transplanted in era 3 (100% vs. 96.0%; p 0.21), however, length of follow up was limited.

Patient survival by donor age and weight for en bloc recipients

As displayed in figure 5, we found no differences in the patient or graft survival for recipients of donors weighing < 10 kg or aged < 2 years compared with those weighing 10-20 kg or those aged 2-5 years.

Discussion:

This is the first pediatric study to report a survival benefit associated with en bloc transplantation of small pediatric kidneys in children compared with remaining of the waiting list for a non-en bloc deceased donor kidney. This is also the first study to report outcomes beyond 5 years for pediatric en bloc recipients and to examine the effect of era on outcomes of en bloc transplantation. Overall, we found significantly higher long-term graft survival and a trend towards better long-term patient survival among en bloc recipients compared with matched non-en bloc deceased donor recipients. Compared with non-en bloc recipients, en bloc recipients who were transplanted in era 1 had significantly lower 1-year graft survival, however, we found no differences in 1-year graft survival between en bloc and non-en bloc recipients for eras 2 and 3. Over the 30-year study period, en bloc transplantations has accounted for only 1.3% of all pediatric deceased donor transplants in the United States. Providers are reluctant to use small pediatric donors in children due to risks of surgical complications such as vascular thrombosis, vascular stenosis and ureteral leak.^{9,26,27} A retrospective study of 4394 pediatric kidney transplants, performed between 1987 and 1995, showed that the risk of graft thrombosis increased when both the donors and recipients were young.²⁸ Similarly, a study of 787 deceaseddonor pediatric kidney transplants that were performed between 1987 and 1990 showed that graft loss due to technical complications was higher in kidneys from small donors.¹⁰ Data suggesting the increased risk of vascular and ureteral complications for small pediatric donors predate recent improvements in anticoagulation protocols and refinement of surgical techniques. Studies have shown that anticoagulation with low dose heparin and aspirin may decrease the risk of post-transplant vascular thrombosis without an increased risk of bleeding.²⁹ Chinnakotla et al. reported no vascular or urological complications in 14 adult en bloc kidneys recipients, transplanted between 1987 and 1999, using the vicryl mesh envelope technique.³⁰ Similarly, Amante et al. demonstrated that placing allografts using in continuity vascular anastomosis was associated with less vascular complications.³¹ Likewise, Sharma et al. reported no vascular complication and only one urine leak among 20 adult en bloc recipients using meticulous surgical techniques including careful ligation of small aortic and caval vessels and no kinking of renal vasculature.¹⁶

We found a higher incidence of graft loss due to thrombosis during the first year post-transplant among en bloc recipients. However, when analysis was stratified by era of

transplantation, lower 1-year graft survival was only seen in recipients of era 1. We found no difference in 1-year graft survival between en bloc and non-en bloc recipients for eras 2 and 3. Although superior long-term outcomes of en bloc transplantation are encouraging, higher risk of early graft loss would need to be taken into account when considering en bloc transplantation of small pediatric kidneys into children. Early graft loss due to vascular complications is devastating for the recipient as it increases risk for HLA sensitization and may necessitate nephrectomy. Furthermore, Centers for Medicare and Medicaid Services evaluate transplant centers based on their 1-year transplant outcomes. Having said that, our study shows temporal improvement in 1-year outcomes for en bloc recipients. The observed improvement in the risk of 1-year graft loss among en bloc recipients may be due to the progressive refinement of surgical techniques. Despite the promising improvement in 1-year outcomes, we suggest that prophylactic heparin or direct oral anticoagulants be considered for en bloc recipients to mitigate the risk of graft loss due to thrombosis.^{32,33}

Previous pediatric studies have failed to document a statistically significant difference in 5-year graft survival between en bloc and standard deceased donor recipients. Filler et al. compared 35 pediatric en bloc recipients (donors < 6 years) with 167 non en bloc (older donor) recipients and found no difference in 5-year graft survival.³⁴ Winnicki et al. compared 126 en bloc with 6756 standard deceased donor recipients, transplanted between 2000 and 2013, and demonstrated a similar 5-year graft survival (adjusted hazard ratio: 1.04; $p = 0.85$) but superior unadjusted 5-year estimated glomerular filtration rate (GFR).³⁵ Similarly, a retrospective study of 57 pediatric en bloc and 2350 pediatric ideal deceased donor recipients, transplanted between 1996 to 2013, found no difference in 3-year graft survival (1.57; 95% CI 0.88-2.79).³⁶ Unlike these studies, we evaluated survival beyond 5 years and found it to be superior in en bloc recipients. Our stratified analysis showed that outcomes became superior mostly in recent years, likely related to improved surgical techniques and better anticoagulation. Although we did not perform the multivariate Cox proportional analysis due to the violation of proportional hazard assumption, the differences in survival were adjusted for age at transplant, gender, race, pretransplant dialysis, transplant center and transplant year by the matched design of our study.

Superior long-term outcomes in en bloc recipients are likely due to the increase in size of small pediatric kidneys with the growth of the recipient, resulting in a progressive improvement in GFR. Pape et al evaluated 15 adult and pediatric kidney transplant recipient pairs who had received kidneys from the same donor and found that adult kidneys in pediatric recipients resulted in persistently low GFR but pediatric kidneys in pediatric recipients resulted in an increase in GFR with the growth of the child.³⁷ Wang et al. studied 6 en bloc kidney transplants from donors < 10 months and found that the mean size of the kidney increased from 4.2 to 7.6 cm six months after the surgery.³⁸ Similarly, a retrospective study of 99 pediatric kidney transplant recipients, transplanted between 1990 and 2005, found that grafts received from pediatric donors doubled in size in the first year after transplantation, and the 3- to 5-year glomerular filtration rate was significantly higher in recipients of pediatric versus adult donors.³⁹ Considering these data, it is not surprising that we found a significantly higher 10-20 year graft survival in en bloc recipients compared with their non-en bloc counterparts.

We found no difference in patient or graft survival among en bloc recipients by donor age or weight. Unlike our findings, a retrospective study of 34 pediatric recipients of small pediatric donor kidneys from Spain showed that 10-year graft survival was significantly lower in donors younger than 3 years compared to those between 3-6 years of age (35.5% vs. 58.6%, $p<0.05$).⁴⁰ Our results may indicate higher surgical expertise in the centers that undertake transplantation of the very young donors in the United States.

We observed that small pediatric en bloc donors had significantly higher KDPI scores compared with matched non-en bloc donors, despite better graft survival of en bloc recipients. Consistent with our findings, a retrospective study of 34 en bloc recipients of small pediatric donors documented a mean KDPI score of 73% in spite of excellent graft survival.⁴¹ The KDPI score of most en bloc transplants performed in the United States between 2010 and 2015 ranged between 51 and 90%.⁴² Computation of KDPI scores is such that smaller weights and heights of small pediatric donors translate into higher scores. KDPI scoring system assumes that kidneys would be transplanted singly and does not account for the added benefit of two kidneys. Our results confirm that KDPI inaccurately predicts the risk of graft failure for en bloc transplants. Considering the poor correlation between the graft survival of en bloc kidneys and their KDPI scores, we suggest that KDPI scoring for small pediatric en bloc kidneys be reevaluated to reconcile it with their good long-term outcomes.

Our study has several limitations. Despite being the largest study of pediatric en bloc transplantation, our sample size is relatively small. We examined a long period, which opens the possibility of the era effect. Many patients with 20-year outcomes were transplanted in an era when outcomes were worse. To mitigate confounding by era, we matched the comparison group for year of transplant. Furthermore, we stratified our analysis by era of transplantation and found either no difference in survival or superior survival for en bloc recipients. Given our small sample size, our study was likely underpowered to detect statistically significant differences in causes of graft loss between different groups. Due to the small numbers, we were also unable to assess temporal changes in the incidence of graft loss due to thrombosis. Finally, we were unable to construct Cox proportional hazard models to compare outcomes between the groups due to the violation of the proportional hazard assumption. Having said that, our results were adjusted for known confounders by the matched design of our study. Furthermore, exact matching for transplant centers was performed to minimize the possibility of selection bias.

Organ shortage is a grave threat to the long-term survival, quality of life, growth potential and neurocognitive development of children. It is critical to expand the existing deceased donor pool for children in order to improve their access to transplantation and shorten their time on dialysis. En bloc transplantation would not only improve organ shortage but would also offer superior long-term graft outcomes. Based on our findings, we propose that en bloc transplantation of small pediatric kidneys be considered for children. Although we found progressive improvement in 1-year graft outcomes for en bloc recipients, we suggest that prophylactic anti-coagulation be considered for en bloc recipients during the first year post-transplant to lower their risk of vascular thrombosis. Additional studies are needed to evaluate temporal changes in post-transplant complication rates for en bloc recipients.

Future studies should also focus on strategies to minimize graft loss during the first year post-transplant after en bloc transplantation.

Abbreviations:

aHR:	Adjusted hazard ratio
ESRD:	End-stage renal disease
GFR:	Glomerular filtration rate
HRSA:	Health Resources and Services Administration
IRB:	Institutional review board
KDPI:	Kidney donor profile index
OPTN:	Organ Procurement and Transplantation Network
SRTR:	Scientific Registry of Transplant Recipients

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Figure 1:
Overall Graft Survival

Figure 2:
Death-censored Graft Survival

Figure 3:
Patient Survival

Figure 4a:
Graft survival by era of transplantation

Figure 4b:
Patient survival by era of transplantation

Figure 5:
Patient survival by donor weight

Table 1:

Demographic and Clinical characteristics of en bloc and matched standard deceased donors

Variable	En bloc donors N = 148	Matched deceased donors N = 581
Age at death/donation (years) Median (IQR)	1.0 (1.0, 3.0)	22.0 (16.0, 31.0)
Gender n (%) Male	82 (55.4)	374 (64.4)
Race n (%)		
White	107 (72.3)	479 (82.4)
Black	40 (27.0)	91 (15.7)
Asian	0 (0.0)	6 (1.0)
Native	0 (0.0)	4 (0.7)
Pacific	1 (0.7)	0 (0.0)
KDPI Median (IQR)	72.50 (63.2, 83.0)	21.50 (8.0, 37.7)
Cause of death n (%)		
Anoxia	57 (38.5)	99 (17.0)
Cerebrovascular/Stroke	9 (6.1)	108 (18.6)
Head Trauma	74 (50.0)	330 (56.8)
CNS tumor	0 (0.0)	4 (0.7)
Other	8 (5.4)	40 (6.9)

Table 2:

Demographic characteristics of transplant recipients

Variables	En bloc recipients	Deceased donor recipients
Age at transplant (years) Median (IQR)	13.1 (8.4, 16.0)	13.3 (8.5, 16.2)
Gender n (%) Male	82 (55.4)	299 (51.5)
Race n (%)		
White	96 (64.9)	383 (65.9)
Black	41 (27.7)	166 (28.6)
Asian	7 (4.7)	19 (3.3)
Native	4 (2.7)	13 (2.2)
Pre-transplant dialysis Yes n (%)	129 (87.2)	504 (86.7)
Cause of ESRD n (%)		
CAKUT	38 (25.7)	137 (23.6)
Glomerulonephritis	23 (15.5)	125 (21.5)
FSGS	20 (13.5)	82 (14.1)
Cystic kidney disease	4 (2.7)	23 (4.0)
HUS	6 (4.1)	10 (1.7)
Other	56 (38.1)	199 (34.5)
Recipient's blood group n(%)		
O	75 (50.7)	314 (54.0)
A	48 (32.4)	198 (34.1)
B	21 (14.2)	52 (9.0)
AB	4 (2.7)	17 (2.9)
HLA mismatch Median (IQR)	4.0 (4.0, 5.0)	4.0 (4.0, 5.0)
Cold ischemia time (hours) Median (IQR)	20.0 (14.0; 25.7)	18.0 (12.0, 25.0)
Delayed graft function N (%)	23 (15.5)	68 (11.7)

Table 3:

Causes of death and graft loss

Causes of death n (%)	En bloc recipients N 21	Matched deceased donor recipients N 117	P value
Graft failure	0 (0.0)	4 (3.4)	0.93
Infection	1 (4.8)	12 (10.3)	
Cardiovascular	2 (9.5)	11 (9.4)	
Cerebrovascular	1 (4.8)	5 (4.3)	
Hemorrhage	0 (0.0)	3 (2.6)	
Malignancy	0 (0.0)	2 (1.7)	
Trauma	0 (0.0)	1 (0.9)	
Miscellaneous	9 (42.9)	37 (31.6)	
Causes of graft loss n (%)	En bloc recipients N 67	Matched deceased donor recipients N 267	P value
Acute rejection	15 (22.4)	55 (20.6)	0.07
Chronic rejection	15 (22.4)	96 (36.0)	
Primary failure	2 (3.0)	5 (1.9)	
Graft thrombosis	8 (11.9)	9 (3.4)	
Infection	3 (4.5)	8 (3.0)	
Recurrent disease	5 (7.5)	22 (8.2)	
Other	19 (28.4)	72 (27.0)	

Table 4:

Causes of graft loss by age at transplant for en bloc recipients

Causes of graft loss N (%)	Age at transplant 0 - <5 years N = 22	Age at transplant 5 - <10 years N = 20	Age at transplant >10 years N = 106	P value*
Acute rejection	1 (4.5)	4 (20.0)	10 (9.4)	0.29
Chronic rejection	0 (0.0)	2 (10.0)	13 (12.3)	
Primary failure	1 (4.5)	0 (0.0)	1 (0.94)	
Graft thrombosis	2 (9.1)	0 (0.0)	6 (5.7)	
Infection	1 (4.5)	1 (5.0)	1 (0.94)	
Recurrent disease	0 (0.0)	1 (5.0)	4 (3.8)	
Other	2 (9.1)	3 (15.0)	14 (13.2)	

*
p value: Fisher's exact test