Transplant International

ORIGINAL ARTICLE

Outcomes of simultaneous pancreas and kidney transplants based on preemptive transplant compared to those who were on dialysis before transplant – a retrospective study

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SUMMARY

Among kidney transplant recipients, the duration of pretransplant dialysis is significantly associated with worse post-transplant outcomes. However, data on the outcomes of preemptive simultaneous pancreas and kidney (SPK) are limited. We analyzed primary SPK recipients transplanted between January 2000 and December 2017. Patients were divided into two groups based on pretransplant dialysis history of preemptive versus non-preemptive. Patient and survival of grafts were outcomes of interest. Of the 644 recipients, 174 (27%) were preemptive and 470 (73%) were not. Most of the baseline characteristics were similar between the groups. In the univariable analysis, the non-preemptive transplant was associated with 54% increased risk for kidney death-censored graft failure (DCGF; HR: 1.54; 95% CI: 1.01–2.35; $P = 0.05$). There was a 29% increased risk after adjustment for confounding factors (HR: 1.29; 95% CI: 0.83–2.02; $P = 0.26$), although this association was not statistically significant. Similarly, there was a 16% increased risk of pancreas DCGF in univariable analysis and 1% after adjustment, which was also not statistically significant. When outcomes were based on the duration of pretransplant dialysis, the duration was not associated with either patient survival or survival of either graft in K-M analysis. In SPK recipients, with pretransplant dialysis history, there was a tendency toward inferior graft survival, mainly for the kidney more than the pancreas.

Transplant International 2020; 33: 1106–1115

Key words
graft survival, pancreas kidney transplant, patient survival

Received: 28 March 2020; Revision requested: 14 April 2020; Accepted: 22 May 2020; Published online: 18 June 2020

Introduction

The importance of obtaining a kidney transplant as quickly as possible and minimizing time on dialysis has been apparent for many years [1,2]. Time on dialysis can strongly affect the eventual survival of a kidney allograft. In the paired-kidney analysis of kidney transplants performed in the United States between 1988 and 1998, graft survival rates at 5 and 10 years were significantly worse for recipients who had spent >24 months on dialysis than for recipients who were on dialysis for <6 months prior to transplantation [3]. While kidney

doi:10.1111/tri.13665

transplantation is the best treatment option for patients with end-stage renal disease (ESRD), the demand for kidney transplants cannot be met by the limited number of available donors [2].

Expected post-transplant survival (EPTS) can be used to stratify expected graft survival for kidney transplant recipients on the waiting list. The four variables which most strongly predict graft survival are used in calculating EPTS, namely dialysis duration, presence of diabetes, patient age, and history of prior solid organ transplant [4]. Therefore, diabetic patients who have been on dialysis for a longer period of time would have a higher EPTS score, indicating worse predicted post-transplant graft survival. One study found that diabetic ESRD patients undergoing preemptive (before starting dialysis) kidney transplant also had a 12% reduction in the risk of death [5]. Recipients of simultaneous pancreas and kidney (SPK) are unique in that after successful transplantation, their diabetes is cured. SPK recipients with a functioning pancreas graft acquire significantly better kidney graft and patient survival than patients with diabetes who received kidney only transplant or those with a failed pancreas graft [6,7]. However, limited data are available regarding kidney and pancreas graft outcomes among SPK recipients who received organs preemptively and outcomes based on the duration of dialysis. Based on the experience with kidney only recipients, we hypothesized that SPK recipients with preemptive transplants would also have better patient and graft survival. Also, we hypothesized that the longer the duration of dialysis, the greater the impact on patient and graft survival.

Methods

Study population

We examined outcomes in all primary SPK transplants at the University of Wisconsin between January 2000 and December 2017. Patients that received any previous transplants were excluded from the study. Donor and recipient characteristics were collected from the University of Wisconsin Allograft Recipient Database (WisARD). The Institutional Review Board at the University of Wisconsin approved this project.

Variables and definitions

Information on transplant recipients included basic demographics of age at the time of the transplant, gender, and race, types of transplant, induction immunosuppressive medication, cold ischemia time, kidney donor profile index (KDPI), and human leukocyte antigen (HLA) mismatch. All the rejections were biopsy-proven. Delayed graft function (DGF) was defined as a need for dialysis within one week of transplant. Pancreas allograft failure was defined based on the current United Network of Organs Sharing (UNOS) criteria for pancreas graft failure: removal of the pancreas graft, re-registration for a pancreas transplant, registration for an islet transplant after receiving pancreas, and the requirement for insulin that is $\geq$0.5 units/kg/day for 90 consecutive days or death [8]. Kidney graft failure was defined as a return to dialysis, or re-transplantation or patient's death. Uncensored graft failure was defined as any cause of graft failure including death and death-censored graft failure (DCGF) as graft failure other than death. The patients were followed until death or until the time both grafts had failed.

Immunosuppression

All patients received induction with either a lymphocyte-depleting agent: antithymocyte globulin (ATGAM; Pharmacia and Upjohn Company, New York, NY, USA), antithymocyte globulin (Thymoglobulin; Genzyme Transplant, Cambridge, MA, USA), and alemtuzumab (Campath-1H; Genzyme Corp, Cambridge, MA, USA), or nondepleting IL-2 receptor inhibitor: basiliximab (Simulect; Novartis Pharmaceuticals Corp, East Hanover, NJ, USA). Most patients were maintained on triple immunosuppressive therapy with prednisone, antimetabolite, and calcineurin inhibitor as previously described [9].

Surgical technique

All pancreas transplants during the study period had enteric drainage of exocrine secretions and systemic venous drainage of endocrine secretions. Most of the kidneys were placed on the left and pancreas on the right side, and the details of the surgical technique were as previously described [10].

Patient selection and evaluation

Any patient with ESRD and diabetes on insulin was considered a potential candidate for SPK. Although there was no absolute age cutoff for SPK transplantation, few patients (n = 10) over age 60 received SPK transplants. Most patients underwent extensive cardiac workup including cardiac catheterization, as previously

described [11]. Contraindications for transplantation parallel other solid organ transplant criteria (cardiovascular disease, active infection, cancer, noncompliance, and poor social support).

Statistical analysis

Continuous data were presented as median with interquartile range, when appropriate, and analyzed using the Kruskal–Wallis test, while categorical data were analyzed using Fisher's exact test or the chi-square test, when appropriate. Patient survival and graft survival were analyzed using Kaplan–Meier analyses. *P* values ≤0.05 were considered statistically significant. Also, putative risk factors associated with graft failure (uncensored or DCGF) of kidney and pancreas graft were studied using univariable and multivariable Cox regression analyses. Basic demographics including non-preemptive transplant, gender, age, race, wait time on the list, types of transplant, depleting induction agent use, recipients body mass index (BMI) types of diabetes, cold ischemia time, KDPI, HLA mismatch, kidney DGF, donor's age, and BMI were included in the univariable analysis and multivariable analysis.

Results

There were a total of 644 primary SPK transplants during the study period, of which 174 (27%) received preemptive transplants and 470 (73%) did not (Table 1). The baseline characteristics were similar in the two groups, except that Caucasians were more common in the preemptive group and there were differences in the induction immunosuppression between two groups. The proportion of recipients with DGF was significantly lower in the preemptive group 7 (4%) compared to the non-preemptive group 56 (12%). None of the other outcomes of interest, including rejection of either graft or one-year patient or death-censored graft survival of either graft, were different between the two groups (Table 2).

Kaplan–Meier survival analysis showed no significant difference in patient survival, kidney uncensored graft survival, and pancreas uncensored or death-censored graft survival (Fig. 1). However, kidney death-censored graft survival was significantly lower in the non-preemptive group, in this unadjusted analysis. This was further investigated by the Cox regression analysis (Tables 3–6). In the univariable analysis for uncensored kidney graft failure, the non-preemptive transplants were associated with a 21% increased risk for graft failure and after adjustment were associated with a 6% increased risk of graft failure, although not statistically significant (Table 3). Similarly, in the univariable analysis, non-preemptive transplants were associated with a 54% increased risk for DCGF (HR: 1.54; 95% CI: 1.01–2.35; $P = 0.05$; Table 4). Even after adjustment of the multiple confounding factors, in the multivariable analysis, the non-preemptive transplant was associated with a 29% increased risk for the kidney DCGF (HR: 1.29; 95% CI: 0.83–2.02; $P = 0.26$), although not statistically significant. Variables significantly associated with increased risk for kidney DCGF were non-Caucasian recipients, kidney delayed graft function, and higher donor age. The only variable associated with a lower risk for kidney DCGF was the higher recipient age.

Similarly, in the univariable analysis of pancreas outcomes, non-preemptive transplant was associated with an 18% increased risk of uncensored graft failure (Table 5), and 9% after adjustment, which was not statistically significant. Likewise, there was a 16% increased risk of pancreas DCGF, although it was not statistically significant (HR: 1.16; 95% CI: 0.82–1.66; $P = 0.40$; Table 6). The only variables statistically significantly associated with increased risk of pancreas DCGF were non-Caucasian, higher KDPI, kidney DGF, and older donor age. Again, higher recipient age was associated with decreased risk of pancreas graft failure. After, adjustment for multiple confounding factors, the non-preemptive transplant was associated with a 1% increased risk for pancreas graft failure, which was also not statistically significant (HR: 1.01; 95% CI: 0.69–1.45; $P = 0.98$). Only non-Caucasian recipients and higher donor age were associated with increased risk of pancreas graft failure, and higher recipient age was associated with decreased risk after adjustment.

Among 470 SPK recipients who received a transplant after being on dialysis, 133 were on dialysis for ≤6 months, 150 were on dialysis for 7–12 months, 123 were on dialysis for 13–24 months, and the remaining 64 were on dialysis for >24 months. By Kaplan–Meier survival analysis, there were no significant differences in patient survival or kidney or pancreas graft survival (Fig. 2).

Similarly, there were no differences in patient survival or graft survival when comparing preemptive SPK to those who were on dialysis for more than 12 months, or more than 24 months, before receiving SPK transplants (Figs S1 and S2).

Discussion

In this large series of more than 600 SPK recipients, 174 (27%) received preemptive kidney transplantation

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Table 1. Baseline characteristics.

Variables	Preemptive SPK (n = 174)	Non-preemptive SPK (n = 470)	P
Male	99 (57%)	299 (64%)	0.12
Median recipient's age at time of transplant (years; IQ range)	42.5 (36.8–48.7)	40.7 (34.8–47.1)	0.07
Caucasian	167 (96%)	412 (88%)	**0.002**
Median wait time on list (IQ range)	95 (40–224)	113.5 (30–250)	0.93
Types of transplant			
DBD	149 (86%)	398 (85%)	0.23
DCD	25 (14%)	72 (15%)	
Types of diabetes			
Type I	169 (97%)	438 (93%)	0.06
Type II/unknown	5 (3%)	32 (7%)	
Induction immunosuppression			
IL-2 receptor antibodies	93 (53%)	276 (59%)	**0.03**
Alemtuzumab	66 (38%)	132 (28%)	
Anti-thymocyte globulin	15 (9%)	62 (13%)	
Median recipient's body mass index (IQ range)	24.9 (22.8–27.6)	24.5 (22.4–27.6)	0.59
Time on dialysis			
1–6 months	NA	133 (28%)	
7–12 months		150 (32%)	
13–24 months		123 (26%)	
>24 months		64 (14%)	
Kidney DGF	7 (4%)	56 (12%)	**0.003**
Median kidney donor profile index (%; IQ range)	21 (9–39)	21 (8–42)	0.72
Median cold ischemia time kidney (hours; IQ range)	15 (11.4–18.7)	15 (11.5–18.3)	0.62
Median cold ischemia time pancreas (hours; IQ range)	14 (10.5–17.2)	14 (10.2–17)	0.47
Median human leukocyte antigen mismatch (out of 6; IQ range)	5 (4–5)	5 (4–5)	0.41
Median donor's age (years; IQ range)	26 (19–39)	27 (19–41)	0.59
Median donor's body mass index (IQ range)	24.0 (21.5–26.5)	23.9 (21.3–27.1)	0.73

Bold signifies statistically significant values ($P < 0.05$). DBD, donation after brain death; DCD, donation after circulatory death; DGF, delayed graft function; IL, interleukin; IQ, interquartile.

before starting dialysis and the others were on dialysis before receiving a SPK. Of those who were on dialysis, the majority (60%) were on dialysis for less than 1 year and only 14% were on dialysis for more than 2 years before receiving transplantation. While looking for the effect of pretransplant dialysis on both patient and graft outcomes, we did not find any statistically significant detrimental effects of pretransplant dialysis on either patient or graft survival; however, there was a tendency toward increased risk of graft failure in the non-preemptive group, mainly for a kidney graft. Furthermore, while looking for the outcomes based on the duration of pretransplant dialysis, there were no significant effects on patient or graft survival of either graft.

The poor outcomes of the patients with diabetes on dialysis have been demonstrated in many studies, for a long time [12–14]. Various factors that are highly prevalent among patients with diabetes and ESRD are associated with poor prognosis, including the presence of significant cardiovascular disease, shorter arteriovenous fistula lifespan compared to nondiabetic patients for hemodialysis, hemodynamic instability during dialysis, and the high susceptibility to various infections [15]. Various studies have shown significant improvement in patients survival among patients with diabetes and ESRD just by getting kidney transplantation alone compared to remaining waitlisted for transplantation [16,17]. However, when comparing patients with diabetes to those without diabetes, graft and patient survival were inferior among patients with diabetes after kidney transplantation alone [18,19]. When comparing kidney graft survival in diabetics undergoing SPK versus deceased donor kidney transplant alone, the SPK provides better graft survival after one year of transplantation [20].

Based on all these published data, there is little doubt that among suitable patients with diabetes and ESRD, SPK is the best option. However, there is limited information about the impact of pretransplant dialysis on SPK recipients. Although older studies among kidney transplant recipients found a strong association between

Table 2. Outcomes.

Variables	Preemptive SPK (n = 174, %)	Non-preemptive SPK (n = 470, %)	P
Kidney rejection within one year post-transplant	27 (16)	68 (14)	0.79
Pancreas rejection within one year post-transplant	15 (9)	49 (10)	0.77
One-year patient survival	169 (97)	460 (98)	0.58
One-year death-censored kidney graft survival	165 (95)	452 (96)	0.45
One-year death-censored pancreas graft survival	159 (91)	422 (90)	0.54

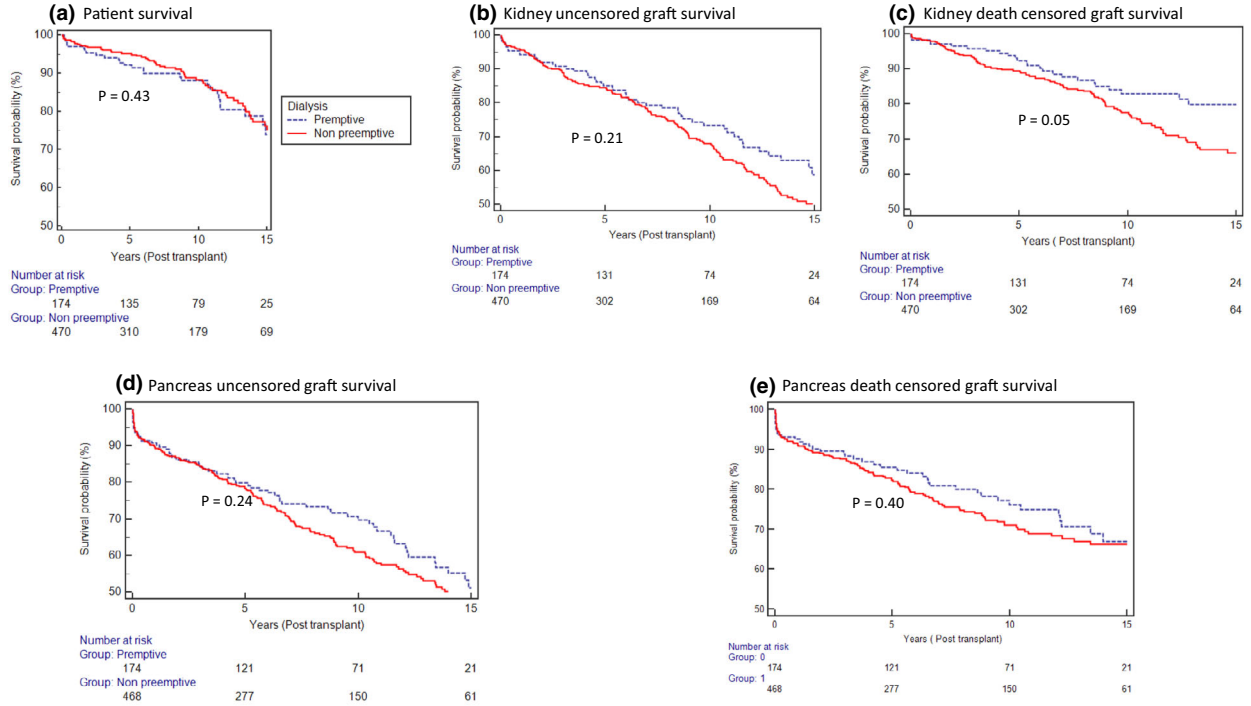

Figure 1 Outcomes between preemptive and non-preemptive simultaneous pancreas and kidney recipients comparing patient survival, kidney uncensored and death-censored graft survival, and pancreas uncensored and death-censored graft survival. For visibility, the scale of the survival probabilities was cut at 50%.

dialysis vintage and graft failure, this association was likely confounded by selection bias and the competing risk of death and may not have a stronger association in transplants performed in the last decade [1,21]. In a recent study, Rose *et al.* found that kidney transplantation with good quality deceased donor kidneys was associated with long-term survival benefit in selected patients even with pretransplant dialysis exposure of 10 or more years [22]. Similarly, in one large retrospective cohort study of approximately 7000 primary kidney recipients, transplanted between 1990 and 2013, Haller *et al.* [21] concluded that although preemptive transplant was associated with superior graft survival compared to the pretransplant dialysis, this association was weaker in transplants performed since 2000. But there are multiple studies in the current era showing better patient and graft outcomes among preemptive kidney transplant recipients compared to those who were on dialysis pretransplant [23,24].

Similarly, among SPK recipients, some older studies found an effect of dialysis vintage on graft or patient survival. In one study of SPK recipients transplanted between 1997 and 2002, Becker *et al.* found a 21% reduction in graft failure among preemptive SPK compared to the non-preemptive transplants [5]. Similarly, in another study of 180 SPK recipients transplanted between 1986 and 2004 preemptive SPK had a significant patient survival benefit, but no effect on graft survival [25]. In another study, among more than 10 000 SPK recipients transplanted between 1990 and 2002, Israni *et al.* [26] found a 17% reduction in kidney allograft failure among preemptive SPK recipients compared with non-preemptive. Finally, using the Organ Procurement Transplant Network/United Network for

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Table 3. Variables associated with kidney uncensored graft failure.

	Univariable analyses			Multivariable analyses		
Variables	HR	95% CI of HR	*P*	HR	95% CI of HR	*P*
Non-preemptive transplant	1.21	0.89–1.64	0.21	1.06	0.77–1.46	0.68
Male recipient	1.01	0.77–1.33	0.91	1.10	0.82–1.47	0.51
Recipient's age (/year)	0.98	0.97–1.01	0.09	0.98	0.96–1.01	0.09
Non-Caucasian recipient	1.86	1.23–2.81	**0.003**	2.11	1.36–3.25	**<0.001**
Wait time on list (days)	1.0	0.99–1.01	0.25	1.01	0.99–1.01	0.07
Donation after brain death	0.83	0.56–1.22	0.36	1.07	0.69–1.63	0.75
Diabetes I	0.36	0.09–1.45	0.15	0.34	0.08–1.43	0.14
Depleting induction	1.10	0.83–1.44	0.49	1.14	0.85–1.52	0.36
Recipient's body mass index	0.99	0.95–1.02	0.48	0.97	0.94–1.01	0.24
Kidney donor profile index (per 10%)	2.06	1.08–3.90	**0.02**	0.67	0.22–2.02	0.48
Kidney cold ischemia time	0.99	0.97–1.02	0.98	1.0	0.97–1.03	0.84
Human leukocyte antigen mismatch (/each)	1.03	0.92–1.16	0.52	1.01	0.89–1.13	0.93
Kidney delayed graft function	2.0	1.36–2.95	**<0.001**	1.91	1.23–2.90	**0.003**
Donor's age(/year)	1.02	1.01–1.03	**<0.001**	1.02	1.01–1.04	**0.01**
Donor's body mass index	1.01	0.97–1.04	0.60	0.99	0.95–1.02	0.56

Bold signifies statistically significant values ($P < 0.05$).

Table 4. Variables associated with kidney death-censored graft failure.

	Univariable analyses			Multivariable analyses		
Variables	HR	95% CI of HR	*P*	HR	95% CI of HR	*P*
Non-preemptive transplant	1.54	1.01–2.35	**0.05**	1.29	0.83–2.02	0.26
Male recipient	0.84	0.59–1.19	0.33	0.99	0.69–1.44	0.98
Recipient's age (/year)	0.95	0.93–0.97	**<0.001**	0.95	0.93–0.97	**<0.001**
Non-Caucasian recipient	2.22	1.35–3.67	**0.002**	2.53	1.50–4.26	**<0.001**
Wait time on list (days)	1.0	0.99–1.0	0.97	1.0	0.99–1.0	0.35
Donation after brain death	1.01	0.59–1.73	0.98	1.38	0.77– 2.45	0.28
Diabetes I	0.3	0.04–2.16	0.23	0.33	0.05– 2.45	0.28
Depleting induction	1.01	0.70–1.45	0.96	1.14	0.78–1.66	0.50
Recipient's body mass index	0.98	0.94–1.03	0.54	0.99	0.94–1.04	0.68
Kidney donor profile index (per 10%)	2.15	0.93–4.97	0.07	0.74	0.19–2.92	0.67
Kidney cold ischemia time	1.01	0.97–1.05	0.55	1.02	0.98–1.06	0.44
Human leukocyte antigen mismatch (/each)	1.04	0.90–1.22	0.55	1.03	0.88–1.20	0.76
Kidney delayed graft function	2.03	1.23–3.35	**0.005**	1.76	1.01–3.08	**0.05**
Donor's age(/year)	1.02	1.0–1.03	**0.02**	1.03	1.0–1.05	**0.03**
Donor's body mass index	0.99	0.96–1.04	0.83	0.97	0.93–1.02	0.26

Bold signifies statistically significant values ($P < 0.05$).

Organ Sharing (OPTN/UNOS) database, Weisman *et al.* compared 1529 preemptive SPK recipients with 1700 SPK recipients who were on dialysis for less than 1 year and also with 2212 SPK recipients who were on dialysis for 1–2 years; they found a significantly lower 7-year patient survival among both groups who were on dialysis compared to the preemptive SPK [27].

While these previous studies suggested inferior outcomes in SPK recipients who were on dialysis before receiving transplants, our study with more recent data did not find a statistically significant negative impact of pretransplant dialysis. Several factors may explain this difference. It may be due in part to the better pretransplant dialysis care more recently. That includes more effective management of various comorbidities associated with dialysis, improvement in the management of hypertension, secondary hyperparathyroidism, and anemia, as well as more efficient hemodialysis, and better management of diabetes. This factor may explain both the reduced impact of preemptive transplants in kidney recipients alone, as

Table 5. Variables associated with pancreas uncensored graft failure.

	Univariable analyses			Multivariable analyses		
Variables	HR	95% CI of HR	*P*	HR	95% CI of HR	*P*
Non-preemptive transplant	1.18	0.88–1.58	0.24	1.09	0.81–1.47	0.53
Male recipient	1.04	0.80–1.35	0.76	1.11	0.84–1.47	0.42
Recipient's age (/year)	0.98	0.96–0.99	**0.04**	0.98	0.96–0.99	**0.04**
Non-Caucasian recipient	1.38	0.90–2.12	0.12	1.50	0.96– 2.33	0.06
Wait time on list (days)	1.0	0.99–1.01	0.24	1.01	0.99–1.0	0.10
Donation after brain death	0.98	0.67–1.43	0.94	1.16	0.77–1.74	0.46
Diabetes I	0.25	0.06–1.02	0.06	0.26	0.06–1.10	0.07
Depleting induction	1.07	0.82–1.39	0.59	1.12	0.86–1.47	0.37
Recipient's body mass index	0.99	0.95–1.02	0.58	0.98	0.95–1.02	0.56
Kidney donor profile index (per 10%)	1.79	0.96–3.35	0.07	0.81	0.30–2.18	0.67
Pancreas cold ischemia time	1.01	0.98–1.04	0.45	1.01	0.98–1.04	0.39
Human leukocyte antigen mismatch(/each)	1.09	0.98–1.22	0.10	1.08	0.96–1.21	0.15
Kidney delayed graft function	1.84	1.26–2.69	**0.001**	1.73	1.14–2.62	**0.009**
Donor's age(/year)	1.01	1.01–1.02	**0.002**	1.01	1.0–1.03	**0.03**
Donor's body mass index	1.02	0.99–1.04	0.21	1.01	0.97–1.03	0.84

Bold signifies statistically significant values ($P < 0.05$).

Table 6. Variables associated with pancreas death-censored graft failure.

	Univariable analyses			Multivariable analyses		
Variables	HR	95% CI of HR	*P*	HR	95% CI of HR	*P*
Non-preemptive transplant	1.16	0.82–1.66	0.40	1.01	0.69–1.45	0.98
Male recipient	0.93	0.68–1.27	0.64	1.06	0.76–1.48	0.73
Recipient's age (/year)	0.96	0.94–0.97	**<0.001**	0.95	0.93–0.98	**<0.001**
Non-Caucasian recipient	1.66	1.04–2.66	**0.03**	1.71	1.04–2.80	**0.03**
Wait time on list (days)	1.0	0.99–1.0	0.99	0.99	0.99–1.0	0.81
Donation after brain death	0.94	0.60–1.48	0.80	1.15	0.71–1.87	0.57
Diabetes I	0.33	0.08–1.35	0.12	0.41	0.10–1.73	0.23
Depleting induction	0.93	0.68–1.29	0.67	1.0	0.72–1.39	0.99
Recipient's body mass index	0.99	0.95–1.03	0.62	1.0	0.96–1.05	0.94
Kidney donor profile index (per 10%)	2.85	1.35–6.03	**0.006**	0.95	0.28–3.23	0.94
Pancreas cold ischemia time	1.02	0.99–1.05	0.26	1.02	0.98–1.06	0.26
Human leukocyte antigen mismatch(/each)	1.09	0.95–1.25	0.21	1.08	0.94–1.24	0.27
Kidney delayed graft function	1.99	1.28–3.11	**0.002**	1.61	0.99–2.62	0.06
Donor's age(/year)	1.02	1.01–1.04	**<0.001**	1.02	1.01–1.05	**0.01**
Donor's body mass index	1.02	0.98–1.06	0.29	0.99	0.96–1.04	0.97

Bold signifies statistically significant values ($P < 0.05$).

well as in SPK recipients. Another factor, which might reduce the impact of preemptive dialysis just in SPK recipients, is the better quality of organs used for SPKs, as the median KDPI and age of the donor were in the mid-20s, and both variables were a predictor of better graft survival in this study. The overall incidence of kidney DGF was also very low, which is one of the factors for predicting graft survival. In an unadjusted analysis, DGF was significantly associated with kidney DCGF. However, after adjustment for the multiple variables, this associated was borderline significant. This could be related to the effect of DGF in the preemptive transplants. DGF in the preemptive group could indicate more of medical or surgical peri-operative complications, in contrast to the DGF related to donor or recipient factors. This was validated in a recent study among SPK recipients with DGF [28]. In that study, after

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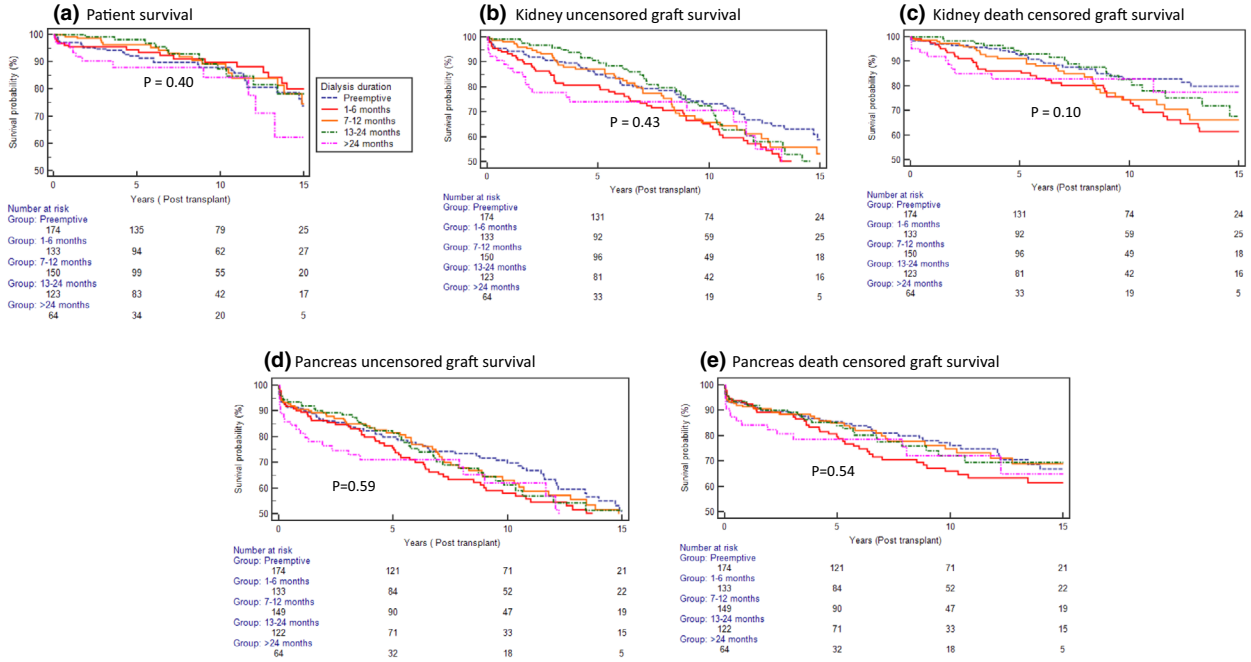

Figure 2 Outcomes based on the various time duration on dialysis pretransplantation. For visibility, the scale of the survival probabilities was cut at 50%.

excluding preemptive SPK recipients and recipients with early kidney graft failure due to the technical issues, kidney DGF did not have a statistically significant detrimental effect on kidney graft survival.

The lack of observed effect of preemptive transplants in SPK recipients may be due to the selection of younger recipients, as the median age of the recipient was in the lower 40s. Although older recipient age was associated with better graft survival, likely due to less immunological risk, the median age of recipients in both groups was very young. This is common in clinical practice, as SPK transplant is rare in recipients more than 60 years of age.

This study has the expected limitations of a single-center observational study, reflecting our specific population and clinical approach. Also, the dialysis vintage among those who were on dialysis before getting SPK transplant in our center was relatively short, as only 14% were on dialysis for more than 2 years. In addition, the 27% of preemptive SPKs at our center is higher than the reported incidence of preemptive SPK transplants of 16% based on the registry data among recipients transplanted between 2000 and 2010 [29]. However, we were able to provide more granular data than is available in registries about the association of pretransplant dialysis with patient and graft survival. Another potential advantage of our single-center data is that it reflects a more homogeneous clinical approach to patient selection, surgical technique, and medication management, in contrast to registry data involving multiple centers.

In conclusion, in this large series of SPK recipients, although we did not find a statistically significant negative impact of pretransplant dialysis on the post-transplant outcomes, there was a tendency toward inferior graft survival, mainly for the kidney more than the pancreas. Our data may be relevant in this era, where the waitlist for getting SPK has been increasing. This could reassure potential SPK recipients and their provider, in case preemptive SPK is not possible. However, we still recommend early referral of the potential SPK candidate and if possible avoiding time on dialysis.

Authorship

SP: conceived and designed the study, analyzed the data, data collection, and prepared the manuscript. KJS and SPRP: collected the data and prepared and edited the manuscript. BCA: analyzed the data and prepared and edited the manuscript. FA, NG, MM, TA-Q, RR, AD, DK, and JO: prepared and edited the manuscript. DAM designed the study and prepared and edited the manuscript.

Funding

The authors disclose no financial disclosure. DAM is the recipient of an unrestricted grant fund from the Virginia Lee Cook Foundation, which supports this study.

Conflicts of interest

The authors have declared no conflicts of interest.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure S1. Outcomes based on the pre-transplant dialysis: preemptive vs. >12 months.

Figure S2. Outcomes based on the pre-transplant dialysis: preemptive vs. >24 months.

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