Influence of Recipient Race on the Outcome of Simultaneous Pancreas and Kidney Transplantation

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**Racial differences on the outcome of simultaneous
pancreas and kidney (SPK) transplantation have not
been well studied. We compared mortality and graft
survival of African Americans (AA) recipients to other
racial/ethnic groups (non-AA) using the national data.
We studied a total of 6585 adult SPK transplants per-
formed in the United States between January 1, 2000
and December 31, 2007. We performed multivariate lo-
gistic regression analyses to determine risk factors as-
sociated with early graft failure and immune-mediated
late graft loss. We used conditional Kaplan–Meier sur-
vival and multivariate Cox regression analyses to es-
timate late death-censored kidney and pancreas graft
failure and death between the groups. Although there
was no racial disparity in the first 90 days, AA pa-
tients had 38% and 47% higher risk for late death-
censored kidney and pancreas graft failure, respec-
tively (p = 0.006 and 0.001). AA patients were twice
more likely to lose the kidney and pancreas graft due
to rejection (OR 2.31 and 1.86, p = 0.002 and 0.008, re-
spectively). Bladder pancreas drainage was associated
with inferior patient survival (HR 1.42, 95% CI 1.15, 1.75,
p = 0.001). In the era of modern immunosupprsion,
AA SPK transplant patients continue to have inferior
graft outcome. Additional studies to explore the mech-
anisms of such racial disparity are warranted.**

**Key words: Outcomes, racial disparity, simultaneous
pancreas–kidney transplantation**

Introduction

Simultaneous pancreas and kidney (SPK) transplantation
is the preferred treatment modality for suitable type 1 di-
abetic patients with end stage renal disease (ESRD) (1–3).
Beside improvement in quality of life, evidence suggests
that a successful SPK transplant has the potential to im-
prove cardiovascular risk profile, reduce the progression of
macrovascular complication of diabetes and improve pa-
tient survival (4–10). With the introduction of more potent
immunosuppressive medications as maintenance therapy
and widespread use of induction agents, the incidence of
acute rejection has decreased and patient and graft sur-
vival has improved in SPK transplant patients in the recent
era (11,12).

Although the incidence of type 1 diabetes mellitus in
African Americans (AA) is lower than that of non-Hispanic
white population, the AA diabetic patients have poorer
metabolic control and higher incidence of end organ dam-
age including ESRD (13–18). Type 1 diabetic AA ESRD pa-
tients have lower rate of access to SPK transplant registra-
tion compared to Caucasians (19,20). It is unclear whether
such lower access to SPK transplantation in AA is the result
of referral bias due to perceived inferiority in the outcome
of SPK transplant for AA patients (20). AA kidney trans-
plant patients have higher risk for kidney graft loss and
require increased levels of immunosuppression (21–25).
However, literature on such racial disparity regarding pan-
creas transplant outcome in the setting of SPK transplan-
tation remains limited and controversial as most reports
were generated from small numbers of AA SPK transplant
patients involved in clinical trials or in single-center studies
(26–28).

We hypothesized that with the improvement in surgical
technique and perioperative care, as well as enhanced im-
munosuppression, both in term of induction and mainte-
nance regimens, in the recent era, there would be no racial
disparity in the outcome in SPK transplantation between
AA and non-AA patients. We undertook a retrospective
analysis of national registry data to determine race-specific
graft survival and mortality risk among SPK transplant pa-
tients. Because early pancreas graft failure is not a rare
event that may contribute to the difference in overall graft
survival, we separately assessed the race-specific risks of
early and late graft loss.

Methods

We included all adult primary simultaneous pancreas and kidney (SPK) trans-
plants performed between January 1, 2000 and December 31, 2007 in the
United States in the national database provided by the Organ Procurement
and Transplantation Network (OPTN)/Scientific Registry of Transplant Recip-
ients (SRTR). The SRTR data system includes data on all donors, wait-listed
candidates and transplant recipients in the US, submitted by the members
of the OPTN, and has been described elsewhere (29). The Health Resources

and Services Administration (HRSA), U.S. Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors. The study was approved by the Institutional Review Board (IRB). The follow-up was up to November 30, 2008. We performed separate analyses for early and late graft failure and death. We defined early graft failure as kidney and/or pancreas loss within the first 90 days after transplantation (30,31). The causes of early and late graft failure were separately examined. Baseline recipient and donor-related characteristics were examined and used in multivariate analyses as appropriate. Surgical modalities in exocrine pancreas anastomosis were identified and included as one of the covariates in the analyses. The use of various immunosuppressive agents, induction and maintenance, and their various combinations were obtained from the initial hospital discharge and incorporated in the analyses. Transplant centers were grouped according to the volume of SPK transplants performed at a given year and used as a covariate in the multivariate analyses.

Demographic and baseline characteristics were compared using Student's t-test and χ^2-test between AA and non-AA SPK transplant patients. For early graft failure (within 90 days of transplant), a multivariate logistic regression model was used to identify the risk factors associated with graft failure adjusting the volume of SPK transplants at individual centers. For late outcome, conditional Kaplan–Meier survival and multivariate Cox proportional regression analysis with backward selection approach was performed for all SPK patients who had survived up to 90 days after transplantation with both functioning grafts for composite transplant outcome including graft failure (kidney and/or pancreas) and death, and subsequently for death-censored graft survival and patient survival. Finally, the causes of late pancreas and kidney graft loss were identified and a multivariate logistic regression was performed to identify the risk factors associated with acute and chronic rejection related graft loss. Software SAS 9.1 was utilized and statistical significance was set at $p \leq 0.05$.

Results

A total of 6742 adult *de novo* SPK transplant patients were identified in the OPTN/SRTR data set between January 1, 2000 and December 31, 2007. After excluding patients who had incomplete or overlapping information on their initial immunosuppression regimens and final outcome and early loss to follow-up (<90 days), the final cohort included 6585 SPK patients. Among these, 931 (14.1%) reported African American as their racial category. The remainders (5654) were classified as non-AA SPK transplant patients. During the study period, the volume of SPK transplants has remained relatively stable for AA and non-AA patients.

Table 1 shows the demographic and baseline characteristics of study population. Compared to non-AA SPK transplant patients, AA SPK transplant patients were younger (38.5 ± 8.6 years vs. 41.9 ± 8.3 years, p < 0.001) with lower body mass index (BMI) (24.6 ± 4.0 vs. 25.0 ± 4.0, p = 0.01), had shorter duration of diabetes (22.9 ± 7.5 years vs. 27.1 ± 8.1 years, p < 0.001), lower proportion of patients with type 1 diabetes mellitus (90.4% vs. 94.2%, p < 0.001) and longer duration of ESRD (2.3 ± 1.9 years vs. 1.6 ± 1.8 years, p < 0.001). AA SPK transplant patients also had lower rate of preemptive transplant (2.5% vs. 10.0%, p < 0.001), more frequent previous blood transfusion (30.2% vs. 24.5%, p < 0.001), higher levels of panel

reactive antibodies at transplant (9.2 ± 20.6 vs. 7.3 ± 18.2, p = 0.008) and received more often organs from younger donors (26.0 ± 10.0 years vs. 26.9 ± 10.8 years, p = 0.007) and AA donors (23.6% vs. 13.4%, p < 0.001). The level of human leukocyte antigen (HLA) mismatch was 4.7 ± 1.0 in AA versus 4.4 ± 1.3 in non-AA SPK transplant patients, respectively (p < 0.001). The delayed kidney graft function was 13.0% in AA compared to 7.2% in non-AA SPK transplant patients (p < 0.001). Fewer AA SPK transplant patients had history of coronary artery disease (4.9% vs. 9.1%, p < 0.001) and peripheral vascular disease (4.8% vs. 7.1%, p = 0.01) prior to transplantation. AA SPK transplant patients also were less likely to have private health insurance (31.0% vs. 51.7%, p < 0.001).

Induction therapy was used among 78.1% of SPK transplant patients with majority of patients receiving T-cell-depleting antibodies (46.6%). Alemtuzumab was used in 7.5% and interleukin 2 receptor (IL-2R) blockers in 23.3% of patients, respectively. Tacrolimus was the most commonly used calcineurin inhibitor (87.2%) and mycophenolate mofetil/mycophenolic sodium the predominant antiproliferative agent used (83.4%). In addition, 96.1% of SPK patients were receiving steroids at the time of discharge. From the initial transplant hospitalization, the combination of tacrolimus and mycophenolate mofetil/mycophenolic sodium accounted for 75% of maintenance regimen at the time of discharge.

The volume of SPK transplants performed by transplant centers across the United States varies from as few as 1 to as many as 59 per year during the study period (mean 16 and median 13). The enteric exocrine pancreas drainage was used in 82.0% of SPK transplants with no difference between AA and non-AA SPK patients. The use of enteric drainage surgical technique increased over the study period from 71.2% in 2000 to 87.0% in 2007 (p < 0.001).

Early pancreas graft failure (less than 90 days posttransplant) is common affecting approximately 10% of SPK transplant patients (31,32). The leading causes of early failure were thrombosis, leak and infection. A total of 585 pancreas (8.9%) and 149 kidney (2.3%) graft were lost within initial 90 days. The most common reason for graft loss was thrombosis, which accounted for 56.1% of pancreas loss and 35.6% of kidney loss, respectively. Multivariate logistical analyses showed that recipient race had no effect on the risk of early kidney or pancreas graft failure (OR 1.09, 95% CI 0.70, 1.69, p = 0.72 for kidney loss, and OR 0.92, 95% CI 0.71, 1.18, p = 0.44 for pancreas loss). Female recipients (OR 1.62, 95% CI 1.14, 2.31, p = 0.008), delayed kidney graft function (OR 15.75, 95% CI 10.96, 22.62, p < 0.001), older donor age (OR 1.02, 95% CI 1.00, 1.03, p = 0.05), African American donors (OR 1.66, 95% CI 1.08, 2.54, p = 0.02), hypertensive donors (OR 1.86, 95% CI 1.09, 3.15, p = 0.02) and bladder pancreas drainage (OR 1.59, 95% CI, 1.07, 2.37, p = 0.02) were associated with increased risk of early kidney graft failure. Female

Table 1: Baseline demographic and clinical characteristics of study population

	Non-AA SPK N = 5654	AA SPK N = 931	p-Value
Age (years) (SD)	41.9 (8.3)	38.5 (8.6)	<0.001
Gender, male (%)	3512 (62.1)	553 (59.4)	0.11
Body mass index (kg/m^2) (SD)	25.0 (4.0)	24.6 (4.0)	0.01
Duration of diabetes (years) (SD)	27.1 (8.1)	22.9 (7.5)	<0.001
Patients with type 1 diabetes mellitus (%)	5323 (94.2)	842 (90.4)	<0.001
Years of dialysis (SD)	1.6 (1.8)	2.3 (1.9)	<0.001
History of dialysis (%)			
Non dialysis	563 (10.0)	23 (2.5)	<0.001
<1 year	1935 (34.2)	213 (22.9)	
1–3 years	2319 (41.0)	441 (47.4)	
>3 years	837 (14.8)	254 (27.3)	
Positive Hepatitis C serology (%)	156 (2.8)	26 (2.8)	0.95
Previous blood transfusion (%)	1387 (24.5)	281 (30.2)	<0.001
Panel reactive antibodies (SD)	7.3 (18.2)	9.2 (20.6)	0.008
Private health insurance (%)	2922 (51.7)	289 (31.0)	<0.001
Education (%)			
Less than high school	112 (2.4)	11 (1.5)	0.30
High school	2089 (44.8)	337 (45.5)	
College	2465 (52.8)	392 (53.0)	
Peripheral vascular disease (%)	402 (7.1)	45 (4.8)	0.01
Coronary artery disease (%)	515 (9.1)	46 (4.9)	<0.001
Donor age (years) (SD)	26.9 (10.8)	26.0 (10.0)	0.007
Donor BMI (kg/m^2) (SD)	23.9 (4.1)	24.2 (4.2)	0.10
Donor gender, male (%)	3827 (67.7)	611 (65.6)	0.22
Donor race, AA (%)	756 (13.4)	220 (23.6)	<0.001
Donor smoking, >20 pack-years (%)	1352 (23.9)	206 (22.1)	0.24
Donor type, SCD (%)	5523 (97.7)	917 (98.5)	0.12
Donor hypertension (%)	378 (6.7)	57 (6.1)	0.52
Donor stroke (%)	1326 (23.5)	213 (22.9)	0.70
Serum creatinine at donation (mg/dL) (SD)	1.0 (0.8)	1.0 (0.5)	0.39
Cold ischemia time (h) (SD)	12.5 (5.4)	12.3 (5.7)	0.41
Delayed graft function (%)	408 (7.2)	121 (13.0)	<0.001
HLA mismatches (SD)	4.4 (1.3)	4.7 (1.0)	<0.001
Surgical technique (%)			0.87
Enteric drainage	4627 (81.8)	764 (82.1)	
Bladder drainage	1027 (18.2)	167 (17.9)	
Center volume (number/year) (%)			<0.001
≤10	2403 (42.5)	414 (44.5)	
11–20	1534 (27.1)	323 (34.7)	
>20	1717 (30.4)	194 (20.8)	
Induction agents (%)			<0.001
ALG/OKT3	2643 (46.8)	427 (50.7)	
IL-2R blockers	1361 (24.1)	175 (18.8)	
Alemtuzumab	447 (7.9)	47 (5.1)	
None	1203 (21.3)	237 (25.5)	
Calcineurin inhibitors (%)			0.09
Tacrolimus	4911 (86.9)	833 (89.5)	
Cyclosporine	518 (9.1)	68 (7.3)	
None	225 (4.0)	30 (3.2)	
Antiproliferatives (%)			0.004
MMF/MPA	4681 (82.8)	813 (87.3)	
mTor inhibitors	637 (11.3)	82 (8.8)	
None	300 (5.3)	34 (3.7)	
Steroids, yes (%)	5431 (96.1)	899 (96.6)	0.46
CMV donor/recipient pair (%)			<0.001
Negative/negative	1236 (21.9)	117 (12.6)	
Negative/positive	1744 (30.9)	191 (20.5)	
Positive/positive	1421 (25.1)	345 (37.1)	
Positive/negative	896 (15.9)	207 (22.2)	
Unknown	357 (6.3)	71 (7.6)	

Table 2: Risk factors associated with early graft failure within 90 days after transplantation

Variables	Kidney graft loss			Pancreas graft loss		
	OR	95% CI	p-Value	OR	95% CI	p-Value
Recipient race, AA	1.09	0.70, 1.69	0.72	0.92	0.71, 1.18	0.44
Recipient gender, male	0.61	0.43, 0.88	0.007	0.74	0.62, 0.88	<0.001
Recipient BMI (kg/m^2)	1.01	0.98, 1.06	0.48	1.03	1.01, 1.05	0.005
Cold ischemia time (h)	0.97	0.94, 1.01	0.13	1.01	0.99, 1.03	0.07
Delayed graft function	15.75	10.96, 22.62	<0.001	1.69	1.27, 2.26	<0.001
Donor age (years)	1.02	1.00, 1.03	0.05	1.02	1.01, 1.03	<0.001
Donor race, AA	1.66	1.08, 2.54	0.02	1.11	0.88, 1.42	0.38
Donor hypertension	1.86	1.09, 3.15	0.02	1.52	1.11, 2.08	0.01
Donor stroke	1.16	0.76, 1.75	0.50	1.26	1.00, 1.57	0.05
Bladder pancreas drainage	1.59	1.07, 2.37	0.02	0.84	0.66, 1.06	0.14
Center volume (number/year) (%)			0.40			<0.001
≤10 (42.8)	Ref	Ref	Ref	Ref	Ref	Ref
11–20 (28.2)	0.75	0.49, 1.15	0.19	0.82	0.66, 1.06	0.06
>20 (29.0)	0.97	0.63, 1.47	0.59	0.65	0.52, 0.80	<0.001

recipients (OR 1.35, 95% CI 1.13, 1.61, p < 0.001), elevated recipient BMI (OR 1.03, 95% CI 1.01, 1.05, p = 0.005), delayed kidney graft function (OR 1.69, 95% 1.27, 2.26, p < 0.001), older donor age (OR 1.02, 95% CI 1.01, 1.03, p < 0.001), donors with history of hypertension or died of stroke (OR 1.52, 95% CI 1.11, 2.08, p = 0.01, and OR 1.26, 95% CI 1.00, 1.57, p = 0.05, respectively) and lower transplant center SPK volume were each associated with increased risk of early pancreas graft loss (Table 2).

During subsequent follow-up, 544 kidney and 513 pancreas grafts were lost. There was a significant difference in the overall outcome of SPK transplantation between AA and non-AA patients (Figure 1A, log-rank, p < 0.0001). This difference was mainly due to higher death-censored graft failure rate among AA SPK transplant patients for both kidney and pancreas (Figures 1B and C, log-rank, p < 0.0001 for both), but not for death (data not shown). This difference was evident early within the first posttransplant year, with actuarial 1, 3 and 5 years kidney and pancreas graft survivals significantly lower for AA SPK transplant patients compared to non-AA SPK transplant patients (Figure 2A and B). Conditional multivariate Cox regression analyses incorporating various confounding factors demonstrated that AA SPK transplant patients have significantly higher adjusted hazard for death-censored kidney graft failure (HR 1.38, 95% CI, 1.11, 1.73, p = 0.006) and for death-censored pancreas graft failure (HR 1.47, 95% CI, 1.17, 1.85, p = 0.001) (Table 3). When subgroup analyses were performed including only SPK patients with a diagnosis of type 1 diabetes the results remained unchanged (data not shown). Additional risk factors associated with late kidney graft failure were higher degree of HLA mismatch (HR 1.12, 95% CI 1.04, 1.20, p = 0.002), delayed graft function (HR 1.38, 95% CI 1.01, 1.88, p = 0.04), older donor age (HR 1.01, 95% CI 1.01, 1.02, p = 0.01), AA donors (HR 1.73, 95% CI 1.39, 2.16, p < 0.001) and more than 20 pack-years smoking history in donors (HR 1.31, 95% CI 1.07, 1.59, p = 0.008). On the other hand, only donor age (HR 1.01, 95% CI 1.01, 1.02, p = 0.001) and AA donors (HR

1.49, 95% CI 1.17, 1.88, p = 0.001) were associated with increased risk of late pancreas graft failure. Contrary to its negative impact on early pancreas graft survival, transplant center volume did not affect late pancreas graft outcome. Immunological complication, acute and chronic rejection, was the leading cause of late graft failure, accounting for 63.6% of kidney and 53.4% of pancreas graft loss, respectively. In particular, compared to non-AA SPK transplant patients, AA SPK transplant patients had a higher rate of acute and chronic rejection as the reported cause of kidney (80.3% vs. 58.9%, p < 0.001) and pancreas (65.7% vs. 50.1%, p = 0.004) failure and were twice more likely to lose their transplants due to rejection (OR 2.31, 95% CI 1.37, 3.87, p = 0.002 for kidney loss, and OR 1.86, 95% CI 1.18, 2.95, p = 0.008 for pancreas loss).

The recipient race has no effect on patient survival (HR 1.05, 95% CI 0.80, 1.39, p = 0.72). Older recipient age (HR 1.02, 95% CI 1.01, 1.03, p = 0.001), longer duration of dialysis (HR 1.07, 95% CI 1.03, 1.11, p < 0.001), history of blood transfusion (HR 1.28, 95% CI 1.06, 1.56, p = 0.01), history of coronary artery disease (HR 1.42, 95% CI 1.09, 1.84, p = 0.01), AA donors (HR 1.52, 95% CI 1.19, 1.94, p < 0.001) and stroke as the cause of death in donors (HR 1.31, 95% CI 1.07, 1.61, p = 0.01) were associated with increased risk for death (Table 4). The surgical modality in exocrine pancreas anastomosis did not affect long-term pancreas and kidney graft survival (HR 1.01, 95% CI 0.82, 1.26, p = 0.90 for pancreas, and HR 1.17, 95% CI 0.94, 1.45, p = 0.16 for kidney, respectively), but the bladder drainage was associated with increased risk for death (overall death and death with graft function) after adjusting for the effects of transplant era (HR 1.42, 95% 1.15, 1.75, p < 0.001).

Discussion

This study showed that despite the absence of racial differences in the early outcome of SPK transplants,
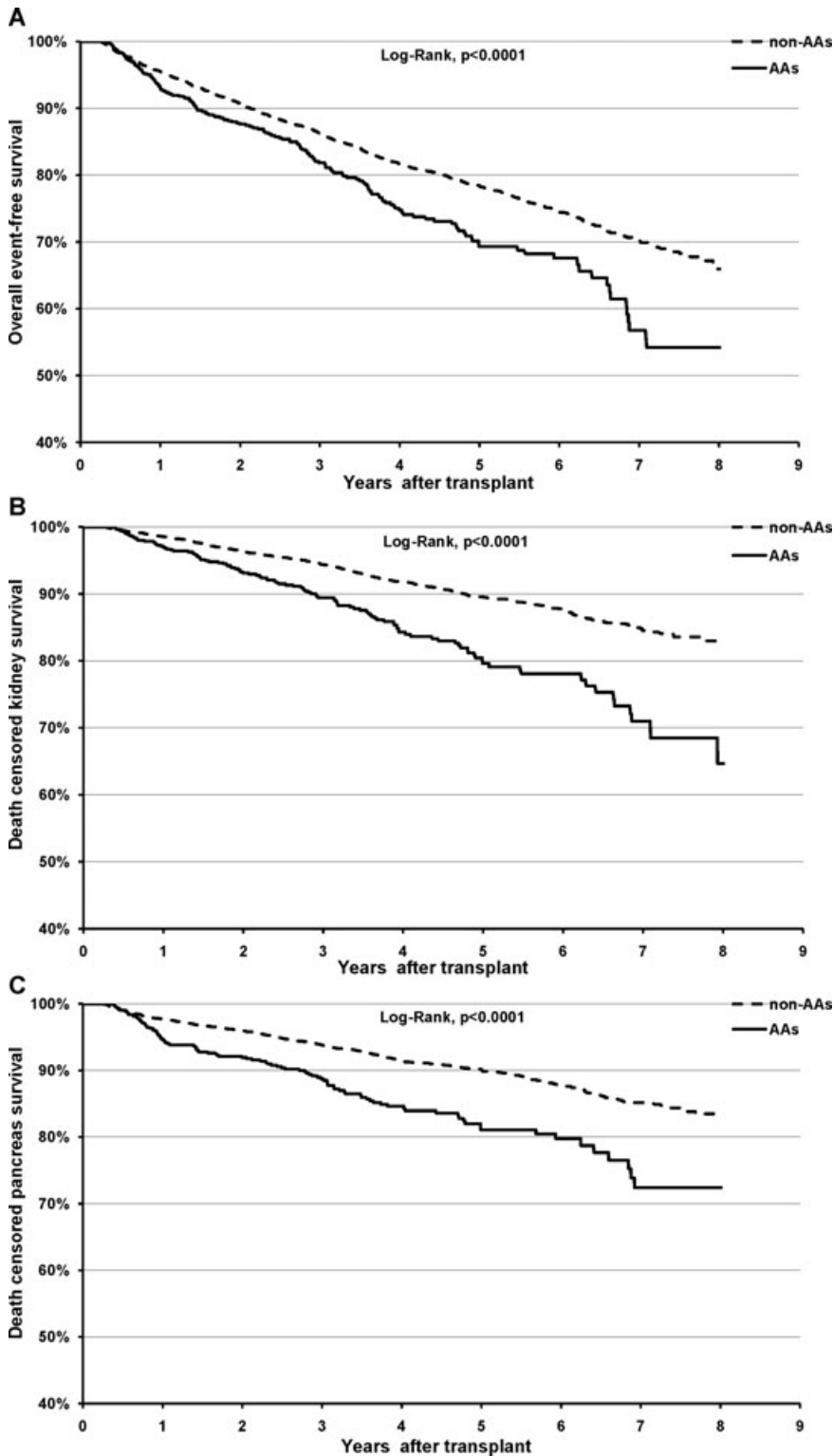
Figure 1: Kaplan–Meier survival analyses between AA and non-AA SPK transplant patients, (A) overall event free survival, (B) death censored kidney graft survival and (C) death censored pancreas graft survival.

the long-term outcome of SPK transplants remains significantly inferior for AA SPK transplant patients in the recent era of modern immunosuppressive therapy.

The racial disparity in the outcome of chronic kidney disease in general, and of kidney transplantation in particular has been widely documented over the past 20 years (15,23,33). For example, AA kidney transplant patients
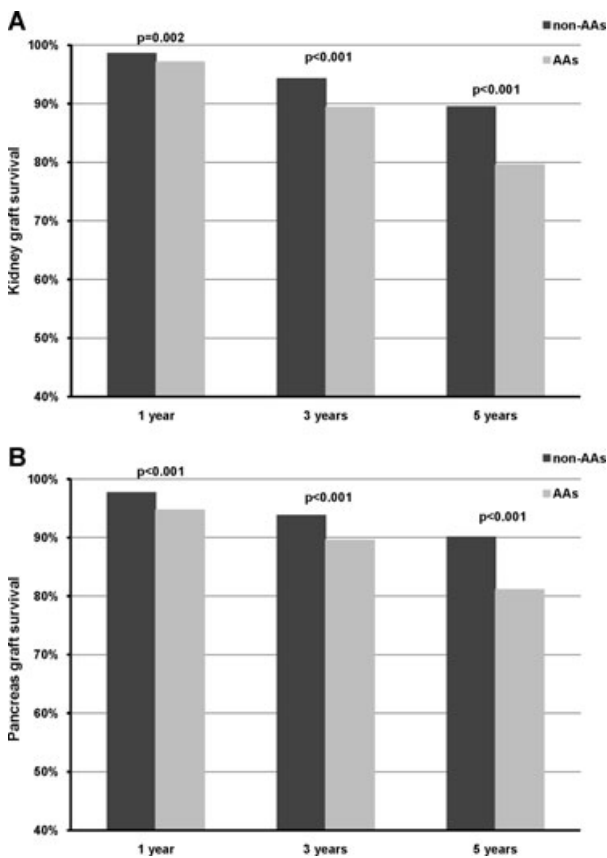
Figure 2: Actuarial graft survival at 1, 3 and 5 years between AA and non-AA SPK transplant patients, (A) kidney and (B) pancreas.

have an inferior kidney graft survival compared to non-AA kidney transplant patients and such difference has been attributed to multiple factors including enhanced immune reactivity and lower socioeconomic status (23,33–35). With enhanced immunosuppression, the incidence of acute rejection has been significantly lowered in all categories of transplant patients (34,36,37). However, the reduction in acute rejection has not lead to the elimination of gap in the outcome between AA and non-AA kidney transplant patients (37).

Previous studies of the outcome of simultaneous pancreas and kidney transplantation have included small numbers of AA SPK transplant patients involved in the clinical trials or in single center experiences (26,27,38). Rogers et al. compared 33 AA to 63 non-AA SPK transplant patients and found significantly lower pancreas graft survival at 1, 3 and 5 years after transplantation (26). The authors also reported inferior late graft function and metabolic control in AA SPK transplant patients (28). Zhang et al. reported, on the other hand, comparable outcome in kidney and pancreas graft survival after 5 years follow-up between 36 AA and 55 non-AA SPK transplant patients (27). In studies comparing the outcome of SPK versus kidney transplant alone using large registry data, AA patients had higher risk for kidney graft failure compared to non-AA patients (21,39). This study is the first comprehensive analysis of racial effects on the outcome of simultaneous pancreas and kidney transplantation in the United States. The use of large sample size and the consideration of multiple important demographic and clinical variables allowed us to obtain a reliable assessment of racial disparity among SPK transplant patients. By analyzing separately the early and late outcome, we were able to delineate the predominant nature of graft failure that occurred during each of the two sequential periods. Whereas the improvement in surgical techniques and perioperative management has probably contributed to the equal early outcome between AA and non-AA SPK transplant patients, the use of more modern immunosuppression has failed to eliminate the gap in long-term graft survival, both kidney and pancreas, between AA and non-AA SPK transplant patients. Such difference in the late graft outcome was not related to the inclusion of a small number of type 2 diabetic SPK transplant patients as subgroup analyses including only type 1 diabetic SPK transplant patients yielded identical results. On the other hand, although we did not include early acute rejection episode as one of the covariates in the analyses due to incompleteness of such information in OPTN/SRTR data (more than 40% missing data at 6 and 12 months follow-up), the fact that AA-SPK transplant patients had more immune-mediated kidney and pancreas graft failure, consistent with findings from previous clinical trial (40), suggests that inadequate immunosuppression, either as result of an inherent biological phenomenon or consequence of poor adherence to prescribed immunosuppressive regimens, or other yet

Table 3: Risk factors associated with late graft loss among SPK transplant patients who survived up to 90 days with both graft function

	Kidney graft loss			Pancreas graft loss		
Variables	HR	95% CI	p	HR	95% CI	p
Recipient race, AA (non-AA)	1.38	1.10, 1.73	0.006	1.47	1.17, 1.85	0.001
Recipient age, (years)	0.97	0.96, 0.99	<0.001	0.96	0.95, 0.97	<0.001
Duration of diabetes, (years)	0.97	0.96, 0.98	<0.001	0.99	0.97, 1.01	0.10
HLA mismatch, (zero)	1.12	1.04, 1.20	0.002	0.98	0.91, 1.04	0.45
Donor age, (years)	1.01	1.01, 1.02	0.01	1.01	1.01, 1.02	0.001
Donor race, AA (non-AA)	1.73	1.39, 2.16	<0.001	1.49	1.17, 1.88	0.001
Donor smoking, (>20 pack-years)	1.31	1.07, 1.59	0.008	1.18	0.97, 1.45	0.10
Delayed graft function, yes (no)	1.38	1.01, 1.88	0.04	0.88	0.61, 1.27	0.50

Table 4: Risk factors associated with late death among SPK transplant patients who survived 90 days with both graft function

Variables	HR	95% CI	p
Recipient race, AA (non-AA)	1.05	0.80, 1.39	0.72
Recipient age, (years)	1.02	1.01, 1.03	0.001
Duration of dialysis, (years)	1.07	1.03, 1.11	<0.001
History of blood transfusion, yes (no)	1.28	1.06, 1.56	0.01
History of coronary artery disease, yes (no)	1.42	1.09, 1.84	0.01
Donor stroke, yes (no)	1.31	1.07, 1.61	0.01
Bladder pancreas drainage, (enteric)	1.42	1.15, 1.75	0.001
Donor race, AA (non-AA)	1.52	1.19, 1.94	<0.001

identified factors, could be responsible for the observed difference in the graft outcome.

Among many other factors that are involved in determining the graft and patient survival, the effect of donor race appears unique in that the use of organs from AA donors was associated with increased risk for inferior outcome. Several studies of large registry data analyses have previously documented similar findings for kidney graft survival in kidney as well as in SPK transplant patients (21,39,41). The mechanism for such observed difference remains unclear despite adjustment of multiple potential confounding factors. The statistically significant difference conferred by donor race, however, does not appear clinically relevant as the difference in actual kidney, pancreas graft loss and death was about 4.7%, 2.2% and 3.4% after 8 years follow-up, respectively. Most importantly, survival advantage of SPK transplantation over dialysis was clearly demonstrated regardless of donor source (2,42). Nevertheless, it is important to recognize such donor race effect so that future studies can be conducted to improve our understanding of such phenomenon.

A notable finding in this study is the impact of surgical modality in exocrine pancreas anastomosis on the outcome of SPK transplantation. Although bladder drainage did not appear to affect pancreas and kidney graft loss, it was associated with higher risk for patient death, overall and with graft function. Possible explanation for the increased risk for death could be related to patient selection bias, higher rate of infectious and metabolic complications associated with bladder drainage and/or the need for enteric conversion in many instances or other as yet poorly understood mechanisms (43).

There are several limitations related to our study. The possibility of confounding for variables that were not collected by OPTN/SRTR could bias our conclusion in one way or another. In addition, such study also is not able to take into consideration of factors that were important in determining the outcome and that are measured during transplant follow-up, such as the degree of blood pressure and glycemic control, compliance with medical care and follow-up, etc., between AA and non-AA SPK transplant patients. We were not able, for example, to study pancreas endocrine function as data such as fasting glycemia, glycated hemoglobin or use of insulin, etc., was not routinely collected by OPTN/SRTR. As always, association should not be inferred as causality, rather as suggestion that additional studies are needed in the field.

In conclusion, despite the improvement in surgical techniques and perioperative care, and the use of potent immunosuppressive regimens in the most recent era, AA SPK patients continue to have inferior kidney and pancreas graft survival. Additional studies are needed to improve our understanding and to reduce such racial disparity on the outcome.

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Disclosure

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References

1. Smets YF, Westendorp RG, van der Pijl JW et al. Effect of simultaneous pancreas-kidney transplantation on mortality of patients with type-1 diabetes mellitus and end-stage renal failure. Lancet 1999; 353: 1915–1919.
2. Ojo AO, Meier-Kriesche HU, Hanson JA et al. The impact of simultaneous pancreas-kidney transplantation on long-term patient survival. Transplantation 2001; 71: 82–90.
3. Reddy KS, Stablein D, Taranto S et al. Long-term survival following simultaneous kidney-pancreas transplantation versus kidney transplantation alone in patients with type 1 diabetes mellitus and renal failure. Am J Kidney Dis 2003; 41: 464–470.
4. Luan FL, Miles CD, Cibrik DM, Ojo AO. Impact of simultaneous pancreas and kidney transplantation on cardiovascular risk factors in patients with type 1 diabetes mellitus. Transplantation 2007; 84: 541–544.
5. Coppelli A, Giannarelli R, Mariotti R et al. Pancreas transplant alone determines early improvement of cardiovascular risk factors and cardiac function in type 1 diabetic patients. Transplantation 2003; 76: 974–976.
6. Jukema JW, Smets YF, van der Pijl JW et al. Impact of simultaneous pancreas and kidney transplantation on progression of coronary atherosclerosis in patients with end-stage renal failure due to type 1 diabetes. Diabetes Care 2002; 25: 906–911.
7. Larsen JL, Colling CW, Ratanasuwan T et al. Pancreas transplantation improves vascular disease in patients with type 1 diabetes. Diabetes Care 2004; 27: 1706–1711.
8. Biesenbach G, Konigsrainer A, Gross C, Margreiter R. Progression of macrovascular diseases is reduced in type 1 diabetic patients

after more than 5 years successful combined pancreas-kidney transplantation in comparison to kidney transplantation alone. Transpl Int 2005; 18: 1054–1060.

9. Salvalaggio PR, Dzebisashvili N, Pinsky B et al. Incremental value of the pancreas allograft to the survival of simultaneous pancreas-kidney transplant recipients. Diabetes Care 2009; 32: 600–602.

10. Morath C, Zeier M, Dohler B, Schmidt J, Nawroth PP, Opelz G. Metabolic control improves long-term renal allograft and patient survival in type 1 diabetes. J Am Soc Nephrol 2008; 19: 1557–1563.

11. Andreoni KA, Brayman KL, Guidinger MK, Sommers CM, Sung RS. Kidney and pancreas transplantation in the United States, 1996–2005. Am J Transplant 2007; 7(5 Pt 2): 1359–1375.

12. Gruessner AC, Sutherland DE. Pancreas transplant outcomes for United States (US) cases as reported to the United Network for Organ Sharing (UNOS) and the International Pancreas Transplant Registry (IPTR). Cecka JM, Terasaki P, eds. Clinical transplants. Los Angeles: Terasaki Foundation Laboratory, 2008: 45–56.

13. Mayer-Davis EJ, Beyer J, Bell RA et al. Diabetes in African American youth: Prevalence, incidence, and clinical characteristics: the SEARCH for Diabetes in Youth Study. Diabetes Care 2009; 32(Suppl 2): S112–S122.

14. Bell RA, Mayer-Davis EJ, Beyer JW et al. Diabetes in non-Hispanic white youth: Prevalence, incidence, and clinical characteristics: the SEARCH for Diabetes in Youth Study. Diabetes Care 2009; 32(Suppl 2): S102–S111.

15. Xue JL, Eggers PW, Agodoa LY, Foley RN, Collins AJ. Longitudinal study of racial and ethnic differences in developing end-stage renal disease among aged medicare beneficiaries. J Am Soc Nephrol 2007; 18: 1299–1306.

16. Crook ED, Patel SR. Diabetic nephropathy in African-American patients. Curr Diab Rep 2004; 4: 455–461.

17. National Institute of Health (NIH), (NIDDK) NIoDaDaKD. 2009 Annual Data Report: Atlas of End-Stage Renal Disease in the United States. 2009.

18. Kirk JK, D'Agostino RB, Jr., Bell RA et al. Disparities in HbA1c levels between African-American and non-Hispanic white adults with diabetes: A meta-analysis. Diabetes Care 2006; 29: 2130–2136.

19. Isaacs RB, Lobo PI, Nock SL, Hanson JA, Ojo AO, Pruett TL. Racial disparities in access to simultaneous pancreas-kidney transplantation in the United States. Am J Kidney Dis 2000; 36: 526–533.

20. Melancon JK, Kucirka LM, Boulware LE et al. Impact of medicare coverage on disparities in access to simultaneous pancreas and kidney transplantation. Am J Transplant 2009; 9: 2785–2791.

21. Weiss AS, Smits G, Wiseman AC. Simultaneous pancreas-kidney versus deceased donor kidney transplant: Can a fair comparison be made? Transplantation 2009; 87: 1402–1410.

22. Young CJ, Gaston RS. Renal transplantation in black Americans. N Engl J Med 2000; 343: 1545–1552.

23. Kerman RH, Kimball PM, Van Buren CT, Lewis RM, Kahan BD. Possible contribution of pretransplant immune responder status to renal allograft survival differences of black versus white recipients. Transplantation 1991; 51: 338–342.

24. Schweitzer EJ, Yoon S, Fink J et al. Mycophenolate mofetil reduces the risk of acute rejection less in African-American than in Caucasian kidney recipients. Transplantation 1998; 65: 242–248.

25. Neylan JF. Immunosuppressive therapy in high-risk transplant patients: Dose-dependent efficacy of mycophenolate mofetil in African-American renal allograft recipients. U.S. Renal Transplant Mycophenolate Mofetil Study Group. Transplantation 1997; 64: 1277–1282.

26. Rogers J, Baliga PK, Chavin KD et al. Effect of ethnicity on outcome of simultaneous pancreas and kidney transplantation. Am J Transplant 2003; 3: 1278–1288.

27. Zhang R, Florman S, Devidoss S et al. A comparison of long-term survivals of simultaneous pancreas-kidney transplant between African American and Caucasian recipients with basiliximab induction therapy. Am J Transplant 2007; 7: 1815–1821.

28. Rogers J, Stratta RJ, Lo A, Alloway RR. Inferior late functional and metabolic outcomes in African American simultaneous kidney-pancreas recipients. Transplant Proc 2005; 37: 3552–3554.

29. Dickinson DM, Ellison MD, Webb RL. Data sources and structure. Am J Transplant 2003; 3(Suppl 4): 13–28.

30. Hill M, Garcia R, Dunn T, Kandaswamy R, Sutherland DE, Humar A. What happens to the kidney in an SPK transplant when the pancreas fails due to a technical complication? Clin Transplant 2008; 22: 456–461.

31. Humar A, Ramcharan T, Kandaswamy R, Gruessner RW, Gruessner AC, Sutherland DE. Technical failures after pancreas transplants: Why grafts fail and the risk factors—A multivariate analysis. Transplantation 2004; 78: 1188–1192.

32. Sansalone CV, Maione G, Aseni P et al. Surgical complications are the main cause of pancreatic allograft loss in pancreas-kidney transplant recipients. Transplant Proc 2005; 37: 2651–2653.

33. Young CJ, Kew C. Health disparities in transplantation: Focus on the complexity and challenge of renal transplantation in African Americans. Med Clin North Am 2005; 89: 1003–1031, ix.

34. Feyssa E, Jones-Burton C, Ellison G, Philosophe B, Howell C. Racial/ethnic disparity in kidney transplantation outcomes: Influence of donor and recipient characteristics. J Natl Med Assoc 2009; 101: 111–115.

35. Organ Procurement and Transplantation Network/Human Resources and Service Administration. 2009. Available at: http://optn.transplant.hrsa.gov/latestData. Accessed April 1, 2010.

36. Gaston RS, Hudson SL, Deierhoi MH et al. Improved survival of primary cadaveric renal allografts in blacks with quadruple immunosuppression. Transplantation 1992; 53: 103–109.

37. Meier-Kriesche HU, Ojo AO, Leichtman AB et al. Effect of mycophenolate mofetil on long-term outcomes in African American renal transplant recipients. J Am Soc Nephrol 2000; 11: 2366–2370.

38. Rogers J, Stratta RJ, Alloway RR, Lo A, Hodge EE. African-American ethnicity is no longer a risk factor for early adverse outcomes in simultaneous kidney-pancreas transplantation with contemporary immunosuppression. Transplant Proc 2004; 36: 1055–1057.

39. Israni AK, Feldman HI, Propert KJ, Leonard M, Mange KC. Impact of simultaneous kidney-pancreas transplant and timing of transplant on kidney allograft survival. Am J Transplant 2005; 5: 374–382.

40. Burke GW, 3rd, Kaufman DB, Millis JM et al. Prospective, randomized trial of the effect of antibody induction in simultaneous pancreas and kidney transplantation: Three-year results. Transplantation 2004; 77: 1269–1275.

41. Swanson SJ, Hypolite IO, Agodoa LY et al. Effect of donor factors on early graft survival in adult cadaveric renal transplantation. Am J Transplant 2002; 2: 68–75.

42. Bunnapradist S, Cho YW, Cecka JM, Wilkinson A, Danovitch GM. Kidney allograft and patient survival in type I diabetic recipients of cadaveric kidney alone versus simultaneous pancreas kidney transplants: A multivariate analysis of the UNOS database. J Am Soc Nephrol 2003; 14: 208–213.

43. Sollinger HW, Odorico JS, Becker YT, D'Alessandro AM, Pirsch JD. One thousand simultaneous pancreas-kidney transplants at a single center with 22-year follow-up. Ann Surg 2009; Epub ahead of print.