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Characteristics of compatible pair participants in kidney paired donation at a single center

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Abstract

Compatible pairs of living kidney donors and their intended recipients can enter into kidney paired donation (KPD) and facilitate additional living donor kidney transplants (LDKTs). We examined 11 compatible pairs (the intended recipients and their intended, compatible donors) who participated in KPD, along with the recipients' 11 matched, exchange donors. The 11 pairs participated in 10 separate exchanges (3 were multi-center exchanges) that included 33 total LDKTs (22 additional LDKTs). All the intended donors were blood group O and female, with a mean living kidney donor profile index (LKDPI) of 27.6 (SD 16.8). The matched donors had a mean LKDPI of 9.4 (SD 31.7). Compatible pairs entered KPD for altruistic reasons (N=2) or due to mismatch of age (N=7) or body/kidney size (N=2) between the recipient and intended donor. In four cases, retrospective calculation of the LKDPI revealed that the matched donor had a higher LKDPI than the intended donor. Of the 22 recipients of LDKTs enabled by the compatible pairs, three were highly sensitized, with PRA >80%. In conclusion, most compatible pairs entered into KPD so that the recipient could receive a LDKT transplant from a donor whose age or body/kidney size were more favorable to post-transplant outcomes.

Keywords

kidney transplant; paired donation; histocompatibility; patient selection; living donors; blood group incompatibility

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Introduction

Over the past decade, the number of living donor kidney transplants (LDKTs) performed via kidney paired donation (KPD) has greatly increased. Previously, kidney transplant candidates were often unable to receive a LDKT due to blood group or crossmatch incompatibility with their intended living donor. Desensitization techniques, however, now allow many transplant candidates to successfully receive a LDKT directly from a blood group or crossmatch incompatible living donor.^{1, 2} The concurrent advent of KPD (also known as kidney exchange) has provided kidney transplant candidates and their intended donors with another way to overcome donor-recipient incompatibility and enable LDKTs.³ KPD transplant expanded from 27 in 2005 to over 500 in 2012 and has increased each subsequent year.⁴

Despite the increase in the number of LDKTs performed via KPD, further growth in KPD has been hampered by a relative lack of living donors with blood group O.⁵ Blood group O donors, who are always blood group compatible with their intended recipients, only need to enter KPD registries due to crossmatch incompatibility against their intended recipients. Blood group O transplant candidates, however, are often blood group incompatible with their intended donors and are sometimes crossmatch incompatible as well. In KPD registries, the relative scarcity of blood group O donors leads to longer waiting times for blood group O recipients awaiting LDKTs.⁶

KPD registries can increase their pool of blood group O donors if they include donor-recipient pairs who are blood group and crossmatch compatible.⁷⁻¹⁰ Entry of these compatible pairs into KPD registries can facilitate LDKTs for multiple incompatible pairs, especially if the compatible pairs include donors who are blood group O and intended recipients who are blood group A, B, or AB. In addition to facilitating more LDKTs, the recipient in the compatible pair can potentially benefit from KPD, by receiving a LDKT from a donor who is younger, better HLA-matched, or better size matched to the recipient, among other potential benefits.⁸ The use of compatible pairs in KPD was initially termed “altruistic unbalanced paired kidney exchange”,^{9, 11, 12} but more recently has been termed “compatible pair participation” (CPP) in KPD.⁸

CPP in KPD has been discussed for years,^{7, 8} but the characteristics of compatible pairs and the potential benefits that they derive from participation in KPD are little known. Ratner et al. described 4 compatible pairs who participated in three separate exchanges at their center.¹¹ Bingaman et al. mentioned their use of 17 compatible pairs in their large, single-center KPD program; the recipients in the compatible pairs all received kidneys from donors who were younger than the initial intended donor.¹³ Centers outside North America have also described their limited experience with CPP in KPD.^{14, 15} Other studies of CPP have provided valuable information but used simulations, rather than describing actual donors and recipients.^{7, 16} In this study, we describe the characteristics and potential benefits of CPP in KPD among 11 compatible pairs at our transplant center.

Patients and Methods

Study terminology

CPP in KPD includes a trio of patients: the one transplant recipient and two living donors. The transplant recipient's "intended" living donor (sometimes called the original, paired, or compatible donor) is the family member or friend who originally volunteers to donate to the transplant candidate. When the intended donor is both HLA and blood group compatible with the intended recipient (i.e. intended donor can donate directly to the recipient, without the need for desensitization or KPD), the intended donor and the recipient form a compatible pair. In CPP in KPD, the recipient receives a LDKT not from their intended donor but instead from the "matched" living donor (sometimes called the actual, swap, or exchange donor).

Study design

We performed a retrospective, single-center study of compatible pairs (the recipients and their intended living kidney donors), along with the recipients' matched donors. The donations and LDKTs occurred at Barnabas Health and Saint Barnabas Medical Center in Livingston, New Jersey, from January 2012 through May 2016. The study protocol was approved by the human subjects Institutional Review Board at Saint Barnabas Medical Center.

Compatible pairs approached for KPD

The possibility of CPP in KPD was broached by the living donor nurse coordinator during her initial intake and evaluation of the potential living donor. To avoid perceptions of coercion or pressure, if the donor failed to express interest in CPP in KPD during that initial approach, then CPP was not discussed further with the potential living donor, either by the nurse coordinator or by other team members. To further avoid perceptions of coercion or pressure, we did not approach the intended recipient regarding CPP in KPD.

Compatible pairs of potential living donors and their intended recipients who were interested in KPD were selected for KPD if they met the following criteria: 1) potential living donor was blood group O; and 2) intended recipient had panel reactive antibody $\leq 20\%$. In addition, we preferred pairs in which: the intended recipient was blood group A, B, or AB (although 1 pair included a recipient who was blood group O); the intended donor was ≤ 40 years old; and the intended donor and recipient were not siblings with each other (although 1 pair were siblings). We did not prospectively track compatible pairs whom we approached about KPD.

Evaluation of compatible pairs

Compatible pairs of intended living donors and their intended recipients were evaluated in accordance with the policies of the Organ Procurement and Transplantation Network (OPTN).¹⁷ For both the recipients and living donors, this evaluation included consultations with a transplant nurse coordinator and nephrologist. The psychosocial evaluation was performed by a masters-level, clinically licensed social worker. The living donors were also evaluated by an independent living donor advocate (ILDA). At SBMC, the ILDA is a trained social worker who does not evaluate transplant recipient candidates. Donor evaluation

included calculation of estimated glomerular filtration rate (eGFR) using the CKD-EPI equation¹⁸ and determination of creatinine clearance by 24-hour collection. Additional psychological or psychiatric evaluation of the intended living donors and intended recipients was performed only if clinically indicated.

All compatible pairs were also evaluated by the nurse practitioner (M.M.M.) who directs our KPD program. This evaluation included discussion of the types of KPD exchanges (single center vs. multi-center) and the potential benefits of KPD (the opportunity to possibly improve the recipient's long-term outcome while also helping incompatible pairs who otherwise might wait for an extended time for a transplant). In discussions of the benefits of receiving a kidney from a younger matched donor, a difference of at least 10 years was explained as being possibly beneficial^{19, 20}. The evaluation also included discussion of the potential disadvantages of KPD, such as a possible delay in donation and LDKT while waiting for a matched donor, the risks of shipping (for multi-center exchanges), and the possibility of a failed exchange (where the intended donor donated but the intended recipient did not receive a LDKT). Each intended donor and recipient in each compatible pair provided informed consent for their participation in KPD.

Study variables and analysis

For each compatible pair, we examined the medical records of the transplant candidate/recipient, their intended living donor, and their matched living donor. We determined if the exchange using the compatible pair was performed internally, within our transplant center, or externally, with other transplant centers. In external exchanges, the matched living donor's evaluation was performed elsewhere, but the records were available at our center.

For the recipients, we also determined the dates of their initial transplant evaluation and receipt of a LDKT. For the living donors, we also included the dates of their start of the donor evaluation (defined as return of the completed donor referral form to our center if evaluated at our center) and donor nephrectomy. For donors evaluated at our center, donor CT angiograms were performed using a 64-slice VCT CT scanner on an AW fast VR software platform that directly calculated kidney volumes (GE Healthcare, Chicago, Illinois). For CT angiograms performed earlier or elsewhere, we estimated the volume of the donated kidney as $(\text{length} \times \text{width} \times \text{height} \times \Pi / 6)$. For each living donor, we retrospectively calculated the living kidney donor profile index (LKDPI), which was published after these exchanges were performed.¹⁹ A higher LKDPI is associated with a higher risk of all-cause allograft failure.

Categorical variables were expressed as proportions, and their proportions among intended vs. matched donors were compared using Fisher's exact test. Continuous variables that were normally distributed were expressed as means (with standard deviations) and compared using t-tests. Continuous variables that were not normally distributed were expressed as medians (with 25%-75% interquartile ranges (IQR)) and compared using Wilcoxon rank-sum tests. Statistical analyses were performed using Stata software (College Station, Texas). 2-sided P-values <0.05 were considered statistically significant.

Results

Compatible pairs in KPD exchanges

From January 2012 through May 2016, we performed 565 LDKTs. There were 244 pairs that were compatible (i.e. did not require desensitization or KPD) and included a living donor who was blood group O and recipient with PRA \leq 20%. Of those 244 compatible donor-recipient pairs, 88 pairs (15.6% of 565) included recipients with blood group A, B, or AB, 145 pairs (25.7%) included donors \leq 40 years old, and 195 (34.5%) pairs included donors who were not siblings with the recipient. Only 41 compatible donor-recipient pairs met all 3 criteria (blood group non-O, donor \leq 40 years old, and donor not siblings with recipient).

During this time, 11 compatible pairs participated in KPD at our center, in 10 different exchanges. The 10 different exchanges included 33 total LDKTs (22 additional LDKTs besides the recipients' transplants). Seven of the exchanges were internal, each involving three pairs of participants. One internal exchange included two compatible pairs (including an O-to-O donor-recipient pair) and one incompatible pair. The other six internal exchanges each included one compatible pair and two incompatible pairs. Three of the exchanges were external, involving donor-recipient pairs at other centers.

We excluded from the analysis one compatible pair that initially wished to participate in KPD but had a narrow time frame within which the intended donor could donate. The compatible pair was slated to participate in an exchange with another center, but that exchange was cancelled on short notice. As a result, the intended donor donated directly to the intended recipient.

Characteristics of LDKT recipients

Characteristics of the 11 transplant recipients who participated in KPD are summarized in Table 1 and detailed in Table 2. All eleven of the recipients were male, and none had PRA $>$ 20%. Only one recipient was blood group O (as part of a compatible O-to-O donor-recipient pair), and the remaining recipients were blood group A, B, or AB. Median time from start of the recipient evaluation until transplant was 555.5 days (IQR 163-999 days) for exchanges performed internally versus 616 days (IQR 96-1245 days) for exchanges performed externally, $P=0.99$.

Characteristics of intended and matched living donors

Characteristics of the 11 intended living donors and 11 matched living donors are detailed in Table 2 and summarized in Table 3. Of the 11 intended donors, all were female, all were blood group O, and 6 (54.5%) were the spouse of the intended recipients. The intended and matched donors differed demographically (Table 3). The matched donors were younger, more likely to be male, and had a lower mean LKDPI.

For intended donors, the median time from donor referral to donation was 167 days (IQR 118-522 days). Median time from donor referral to living donation was similar for intended

donors who participated in internal exchanges (162.5 days, IQR 138-573.5) vs. external exchanges (229 days, IQR 93-416), $P=0.84$.

Reasons for CPP in KPD

Of the 11 compatible pairs, 7 (63.6%) entered into KPD to allow the recipient to receive a younger kidney (Table 4). Two pairs (18.2%) entered into KPD due to size mismatch between the intended donor and recipient. In the first pair that entered KPD due to size mismatch (exchange #6B), the intended and matched donor were similar in their weight. However, the calculated volume of the intended donor's kidney was 113 mL, versus 191 mL for the matched donor's kidney. In the second pair (exchange #8), the recipient outweighed the intended donor by 58.5 kg (Table 2). The matched donor was 27.2 kg heavier than the intended donor (Table 4). Finally, two pairs (18.2%) entered into KPD for purely altruistic reasons, to help incompatible pairs receive LDKTs.

Benefits to recipients of CPP in KPD

Table 4 shows the age, weight, and HLA matching benefits, if any, of KPD for the recipients in the compatible pairs. Compared to the intended donors, none of the matched donors was better matched with the recipient at the HLA-B loci, and only three of the matched donors were better matched at the HLA-DR loci. The two recipients who entered KPD for altruistic reasons received LDKTs from a matched donor who was either older than the intended donor (by 14.8 years, exchange #6A) or smaller in size than the intended donor (by 14.1 kg, exchange #10).

Seven of the 11 recipients received a LDKT from a matched donor whose LKDPI was lower than the LKDPI of the intended recipient (Table 4). These 7 recipients received LDKTs from matched donors whose LKDPIs were >20 points lower than the LKDPIs of the intended donors. Of the 4 recipients whose matched donor had a higher LKDPI than the intended donor, one recipient entered into KPD for altruistic reasons (exchange #6A). The other three recipients received LDKTs from matched donors whose LKDPIs were slightly (<20 points) lower than the LKDPIs of the intended donor (exchanges #1, 3 and 4), even though the matched donors were younger than the intended donors.

All 11 recipients had at least 6 months of followup. Mean serum creatinine at 6 months was 1.30 ± 0.22 mg/dL (Table 1), and individual serum creatinine concentrations are listed in Table 2 for each recipient. Eight recipients had at least 12 months of follow-up, and their mean serum creatinine at 12 months was 1.28 ± 0.15 mg/dL. After a median of 1.02 years of follow-up (IQR 0.90-2.24 years), there were no allograft losses or patients deaths among the 11 recipients in the compatible pairs.

Additional LDKTs facilitated by CPP in KPD

The 11 compatible pairs participated in paired exchanges that included 22 other LDKT recipients (in addition to the 11 compatible recipients). These additional LDKT recipients included 14 recipients at SBMC and 8 recipients at other transplant centers (Table 5). Among the 14 additional recipients at SBMC, the mean serum creatinine at 6 months was 1.28 ± 0.35 mg/dL, and there were no allograft losses after a median of 0.99 (IQR 0.90-2.24)

years of follow-up. Three of the 22 other LDKT recipients were highly sensitized, with PRA >80%. There was no difference in the proportions of sensitized vs. unsensitized patients between the LDKT recipients at SBMC vs. other centers (P=0.61).

Discussion

In this single-center case series, we describe 11 compatible pairs who participated in KPD, along with the recipients' 11 matched, exchange donors. Although CPP in KPD was proposed nearly a decade ago,^{7, 8} relatively few compatible pairs appear to have participated in KPD. Bingaman et al. mentioned 17 compatible pairs among 134 total KPD LDKTs over a 3 year period.¹³ The National Kidney Registry, a large multi-center KPD registry, reported facilitating 1392 paired transplants from 2008 through 2nd quarter 2016, of which only 33 consisted of compatible pairs.²¹ Only 26 of those compatible pairs, however, included a donor who was blood group O, and only 16 of the pairs consisted of a blood group O donor and a non-O recipient.²¹ At our center, our 11 compatible pairs also comprised only a small proportion of our 565 LDKTs during the study period.

To help compatible pairs to weigh the benefits of their potential participation in KPD, transplant centers attempt to assess the quality of possible matched donors and then discuss these donors with the compatible pairs. In CPP in KPD, the intended recipient should ideally receive a kidney of measurably “better” quality. However, there is uncertainty regarding how to best quantify the quality of kidneys from living donors. In seeking “better” kidneys for the recipients in their compatible pairs, transplant centers can use individual factors (e.g. donor age, kidney volume, HLA matching) or composite metrics (e.g. LKDPI). Furthermore, there is no consensus regarding what constitutes a meaningful difference in donor quality between two potential living donors. As a result, different transplant centers will likely vary in which matched donors they accept for their compatible pairs who enter into KPD.

In our study, for 4 of the 11 of the compatible pairs, the LKDPI of the matched donor was higher than the LKDPI of the intended donor, suggesting that the matched donor might have shorter allograft survival than the intended donor. At the time of transplant for those four compatible pairs, the LKDPI was neither published nor available for calculation. In three of those pairs, the matched donor's LKDPI was higher than the intended donor's LKDPI despite the matched donor being younger than the intended donor. In those three pairs, the matched donor's LKDPI was only slightly (<20 points) higher than the intended donor's LKDPI. The clinical significance of such small increments and differences in LKDPI is unclear. The LKDPI's predictive discrimination is limited, with a C-statistic of only 0.59.¹⁹

Despite its limitations, however, the LKDPI can serve as an objective starting point when patients and transplant centers seek to assess the potential benefits of CPP in KPD.²² Among recipients of deceased donor kidney transplants, OPTN already mandates that transplant centers inform and consent recipients if the donor has a kidney donor profile index (KDPI) >85%,¹⁷ despite the known limitations of the KDPI.^{23, 24} In the future, transplant centers may consider discussing the LKDPI with compatible pairs who participate in KPD. In particular, centers should transparently discuss the LKDPI when the matched donor's LKDPI is significantly higher (“worse”) than the intended donor's LKDPI.

The uncertainty in how to assess and communicate the benefits of CPP in KPD raises several ethical issues.^{9, 12, 25} Transplant centers have a potential conflict of interest regarding CPP in KPD, given that CPP results in more LDKTs. Most transplant centers wish to perform more transplants and bring the benefits of transplant to as many recipients as possible; this desire may conflict with the needs and interests of the compatible pair. For example, situations may arise in which the recipient in the compatible pair may derive relatively little benefit from CPP in KPD. Alternatively, the benefit from CPP in KPD may be debatable (e.g. the matched donor has a larger kidney volume but the same LKDPI as the intended donor). Compatible pairs may feel pressure, whether from themselves or the transplant center, to proceed with KPD. For the intended donors in the compatible pairs, the ILDA may play a crucial role in advocating for the intended donor's interests. In some cases, such as exchange 6A in our series, the compatible pair may enter into KPD for purely altruistic reasons, without any expectation of benefit to the intended recipient. Some older recipients with a compatible but much younger donor may prefer to enter CPP. CPP in KPD may also benefit from additional evaluation and oversight (e.g. by a hospital ethics committee) beyond that provided by the ILDA.

Most of our compatible pairs participated in internal exchanges (within our center) rather than in external exchanges (with other centers via multi-center KPD registries). There are several potential reasons for this. First, OPTN policy mandates that participants in KPD be informed of the possible risks of a shipped kidney.¹⁷ Some compatible pairs, when informed of this small but possible risk, may prefer to participate in a single-center exchange, to minimize the risks of shipping. Second, compatible pairs may prefer to donate or receive a LDKT as soon as possible, without delay. Multi-center exchanges can involve many pairs at many centers and require additional time to schedule. In our study, there were only three external exchanges, but the time to donation or LDKT was similar for internal vs. external exchanges. The mere perception, however, that multi-center exchanges may require additional time to organize may cause the compatible pairs and transplant center to prefer internal exchanges. Third, for transplant centers, internal exchanges may be logistically easier than external exchanges to coordinate. The possible and perceived logistical, administrative, and financial burdens of external exchanges may make internal exchanges a more attractive option for transplant centers.

Despite these possible disadvantages of multi-center exchanges, CPP in multi-center, rather than single center, KPD registries may provide benefits to recipients. Compatible pairs may be more likely find a better-matched donor if they enter a large multi-center KPD registry, versus participating in a smaller, single-center KPD exchange. The relative merits of receiving a LDKT from a donor who is better HLA-matched vs. younger vs. larger in size are debatable.²⁶ Older age of the living donor appears to be associated with allograft failure, although this increased risk starts at 35 or 40 years of age in some models²⁰ or 50 or 60 years of age in other models.¹⁹ Tools such as the LKDPI may help compatible pairs and transplant centers to weigh the relative merits of better matching of age, size, and HLA loci in the matched donor. Multi-center registries may also be able to organize larger loops and chains of LDKTs, so that each compatible pair facilitates a large number of LDKTs.

This study should be interpreted in light of its limitations. First, we describe only 11 compatible pairs, so our findings should be interpreted cautiously. Nevertheless, prior reports have not detailed the age, matching, and other benefits of CPP in KPD.

Second, this was a single center study, so our findings are not necessarily generalizable to other centers. As a larger volume center, our practices regarding LDKT and KPD likely differ from the practices of lower volume centers. We may differ from other centers regarding which benefits of CPP (better matching of age, vs. HLA or size) that we chose to prioritize and emphasize. Other centers may elect to include not only compatible pairs where the intended donors are blood group O, but also compatible pairs where the intended donors are blood group A, B, or even AB.

Third, we lack precise data on the number of compatible pairs whom we approached for participation in KPD and how many approached pairs declined to participate in KPD. Future studies should prospectively track consent rates for CPP in KPD. Very few donor-recipient pairs (88 of 565, 15.6%) were compatible with a donor who was blood group O, recipient with PRA 20%, and recipient with blood group A, B, or AB. One area of particular interest is the number of compatible pairs who initially agree to participate in KPD but fail to find an advantage and ultimately elect not to participate in KPD.

In conclusion, compatible pairs comprised a small proportion of LDKTs at our center. Compatible pairs participated in KPD to ameliorate age or size mismatches between the recipient and intended donor. Future studies of compatible pairs should examine pairs' preferences, if any, regarding internal vs. external exchanges and regarding better matching of age vs. size vs. HLA. Better understanding of the preferences of compatible pairs might allow transplant centers to better meet the needs of compatible pairs and thereby increase CPP in KPD.

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Table 1
Characteristics of 11 kidney transplant recipients whose compatible pairs participated in KPD

N	11
Age in years, mean (standard deviation)	54.6 (14.1)
Male, n (%)	11 (100%)
White race, n (%)	8 (72.7%)
College graduate, n (%)	4 (36.4%)
Married, n (%)	8 (72.7%)
Weight in kg, mean (SD)	91.8 (19.8)
Body mass index, mean (SD)	30.4 (6.0)
Blood group	
A	4 (36.4%)
AB	2 (18.2%)
B	4 (36.4%)
O	1 (9.1%)
Prior kidney transplant recipient, n (%)	1 (9.1%)
Panel reactive antibody, Class 1	
0-5%	10 (90.9%)
6-20%	1 (9.1%)
21% or greater	0
Panel reactive antibody, Class 2	
0-5%	11 (100%)
6-20%	0
21% or greater	0
Days from evaluation to transplant, median (IQR)	600 (158-1210)
Type of kidney exchange	
Internal exchange within our single center	8 (72.7%)
External exchange with other centers	3 (27.3%)
Serum creatinine at 6 months post-transplant in mg/dL, mean (SD)	1.30 (0.22)

Table 2
Characteristics of 11 kidney transplant recipients and 22 living donors in compatible pair participation in KPD

Exchange	ABO	Age	Wt (kg)	SCr at 6 mo	Donor type	Relation to recipient	ABO	Age	Race	Sex	Wt (kg)	HLA mismatch	LKDPI	D/R weight ratio	eGFR	24h CrCl	Kidney Volume (mL)
1	A	55.1	88.5	1.51	Intended	Spouse	O	51.8	Asian	F	53.5	1A, 2B, 2DR	21	0.61	106	176	152
					Matched		A	36.8	Black	F	65.8	0A, 2B, 2DR	25	0.74	108	92	121
2	A	62.1	91.2	1.13	Intended	Spouse	O	59.8	White	F	62.6	1A, 2B, 1DR	44	0.69	85	92	142
					Matched		A	41.6	White	F	54.4	2A, 2B, 2DR	7	0.60	109	132	186
3	B	70.0	104.3	1.20	Intended	Sibling	O	58.0	White	F	91.2	2A, 1B, 1DR	25	0.87	96	130	266
					Matched		B	41.8	White	F	72.6	1A, 2B, 2DR	37	0.70	109	145	153
4	B	69.7	81.6	1.22	Intended	Spouse	O	65.2	White	F	49.0	2A, 2B, 2DR	51	0.60	93	115	177
					Matched		B	52.3	Black	F	84.4	2A, 2B, 2DR	69	1.03	84	94	187
5	A	34.0	76.2	1.27	Intended	Spouse	O	59.1	White	F	57.2	1A, 1B, 1DR	16	0.75	101	115	210
					Matched		A	29.6	White	F	74.8	2A, 1B, 0DR	-8	0.98	121	164	215
6A	A	73.7	102.1	1.35	Intended	Child	O	46.1	White	F	65.8	0A, 1B, 1DR	21	0.64	104	180	191
					Matched		A	60.9	White	F	80.7	1A, 2B, 1DR	44	0.79	96	115	121
6B	O	39.2	66.8	1.66	Intended	Parent	O	65.2	White	F	66.8	1A, 1B, 1DR	37	1.00	81	124	113
					Matched		O	46.1	White	F	65.8	1A, 1B, 1DR	-2	0.99	104	180	191
7	AB	58.8	66.2	0.89	Intended	Spouse	O	55.2	Asian	F	59.0	1A, 2B, 1DR	12	0.89	82	103	202
					Matched		A	23.4	White	M	96.2	2A, 2B, 1DR	-21	1.45	114	207	174
8	B	37.2	135.2	1.21	Intended	Other relative	O	49.1	Black	F	76.7	2A, 2B, 2DR	55	0.57	100	112	171
					Matched		B	40.8	White	M	103.9	2A, 2B, 2DR	10	0.77	109	142	264
9	AB	44.1	95.3	1.30	Intended	Spouse	O	47.0	White	F	65.3	2A, 2B, 2DR	17	0.69	104	127	124
					Matched		AB	24.0	White	M	59.0	2A, 2B, 1DR	-23	0.62	128	215	179
10	B	56.0	103.0	1.60	Intended	Friend	O	42.1	White	F	104.3	1A, 2B, 1DR	4	1.01	111	137	144
					Matched		B	40.4	White	M	90.3	1A, 2B, 0DR	-34	0.88	114	151	154

D/R weight ratio is donor/recipient weight ratio
 eGFR is calculated via the CKD-EPI equation and expressed as mL/min per 1.73 m²
 CrCl is expressed as mL/min

Table 3
Characteristics of the intended and matched living kidney donors who participated in compatible KPD

	Intended (original) donor (N=11)	Matched (actual) donor (N=11)	P-value
Age in years, mean (SD)	54.4 (7.8)	39.8 (11.3)	0.002
Male, n (%)	0 (0%)	4 (36.4%)	0.09
White race, n (%)	7 (63.4%)	9 (81.8%)	0.64
College graduate, n (%)	6 (54.6%)	5 (45.5%)	>0.99
Married, n (%)	9 (81.8%)	4 (36.4%)	0.08
Relationship to recipient		Not applicable	--
Child	1 (9.1%)		
Parent	1 (9.1%)		
Sibling	1 (9.1%)		
Other relative	1 (9.1%)		
Friend	1 (9.1%)		
Spouse	6 (54.6%)		
Weight in kg, mean (SD)	68.3 (16.6)	77.1 (15.6)	0.22
Body mass index, mean (SD)	25.5 (4.0)	27.3 (5.5)	0.39
Blood group			--
A	0	5 (45.5%)	
AB	0	1 (9.1%)	
B	0	4 (36.4%)	
O	11 (100%)	1 (9.1%)	
Donor/recipient weight ratio			0.54
1.0	2 (18.2%)	2 (18.2%)	
0.9 to <1.0	0	2 (18.2%)	
0.8 to <0.9	2 (18.2%)	1 (9.1%)	
0.7 to <0.8	1 (9.1%)	3 (27.3%)	
0.6 to <0.7	5 (45.4%)	2 (18.2%)	
0.5 to <0.6	1 (9.1%)	1 (9.1%)	
<0.5	0	0	
CKD-EPI eGFR in mL/min per 1.73 m ² , mean (SD)	96.6 (10.2)	108.7 (11.7)	0.02
24 hour creatinine clearance in mL/min, mean (SD)	128.3 (27.6)	148.9 (40.8)	0.18
Donor kidney volume (mL)	172.1 (44.1)	177.0 (41.0)	0.79
LKDPI score, mean (SD)	27.6 (16.8)	9.4 (31.7)	0.11

Table 4
Age, weight, kidney volume, HLA-matching, and LKDPI advantage (if any) of the matched (vs intended) living kidney donor*

Exchange	Years younger	Kg heavier	mL larger in kidney volume	Fewer –B locus mismatches	Fewer –DR locus mismatches	Points lower (better) LKDPI	Advantage sought by compatible pair in KPD	Internal vs external
1	15.0	12.2	-31	0	0	-4	Age	Internal
2	18.2	-8.2	44	0	-1	37	Age	Internal
3	16.2	-18.6	-112	-1	-1	-11	Age	External
4	13.0	35.4	9	0	0	-19	Age	Internal
5	29.5	17.7	6	0	1	24	Age	Internal
6A	-14.8	15.0	-70	-1	0	-22	None- altruism	Internal
6B	19.1	-0.9	78	0	0	38	Kidney size and age	Internal
7	31.8	37.2	-29	0	0	33	Age	External
8	8.3	27.2	93	0	0	45	Size	External
9	23.0	-6.4	55	0	1	40	Age	Internal
10	1.6	-14.1	10	0	1	38	None- altruism	Internal

Negative values (highlighted in bold) for years younger, kg heavier, mL larger in kidney volume, fewer HLA mismatches, and points lower LKDPI signify that the matched donor was actually older, lighter, smaller volume kidney, less matched, or had a higher (worse) LKDPI than the intended donor, respectively.

Table 5
Characteristics of 22 additional LDKTs facilitated by compatible pairs

	LDKTs performed internally at SBMC	LDKTs performed externally
N	14	8
Age in years, mean (SD)	55.0 (10.3)	48.6 (13.7)
Male, n (%)	10 (71.4%)	
White race, n (%)		
Blood group		
A	3 (21.4)	2 (25.0%)
AB	0	1 (12.5%)
B	2 (14.3%)	1 (12.5%)
O	9 (64.3%)	4 (50.0%)
Panel reactive antibody		
0-5%	10 (71.4%)	5 (62.5%)
6-20%	1 (7.1%)	0
21-80%	2 (14.3%)	1 (12.5%)
>80%	1 (7.1%)	2 (25.0%)
Serum Cr at 6 months post-transplant in mg/dL, mean (SD)	1.28 (0.35)	--