Number of Donor Renal Arteries and Early Outcomes after Deceased Donor Kidney Transplantation

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Key Points

- Transplanted kidneys with multiple arteries have similar delayed graft function and 90-day graft failure compared with single-artery kidneys.
- Deceased donor kidneys with multiple renal arteries have a longer cold ischemia time at transplantation compared with those with single arteries.
- Kidneys needing spatulation to single anastomoses may experience more delayed graft function than single-artery or other multiartery kidneys.

Abstract

Background Anatomic abnormalities increase the risk of deceased donor kidney discard, but their effect on transplant outcomes is understudied. We sought to determine the effect of multiple donor renal arteries on early outcomes after deceased donor kidney transplantation.

Methods For this retrospective cohort study, we identified 1443 kidneys from 832 deceased donors with ≥1 kidney transplanted at our center (2006–2016). We compared the odds of delayed graft function and 90-day graft failure using logistic regression. To reduce potential selection bias, we then repeated the analysis using a paired-kidney cohort, including kidney pairs from 162 donors with one single-artery kidney and one multiartery kidney.

Results Of 1443 kidneys included, 319 (22%) had multiple arteries. Multiartery kidneys experienced longer cold ischemia time, but other characteristics were similar between groups. Delayed graft function (50% multiartery versus 45% one artery, P=0.07) and 90-day graft failure (3% versus 3%, P=0.83) were similar between groups before and after adjusting for donor and recipient characteristics. In the paired kidney analysis, cold ischemia time was significantly longer for multiartery kidneys compared with single-artery kidneys from the same donor (33.5 versus 26.1 hours, P<0.001), but delayed graft function and 90-day graft failure were again similar between groups.

Conclusions Compared with single-artery deceased donor kidneys, those with multiple renal arteries are harder to place, but experience similar delayed graft function and early graft failure.

KIDNEY360 2: 1819–1826, 2021. doi: https://doi.org/10.34067/KID.0005152021

Introduction

Although kidney transplantation provides the best survival and quality-of-life for patients with ESKD, the availability of transplantation is limited by an organ shortage in the United States (1–3). Given 20% of recovered deceased donor kidneys are discarded, strategies to improve access to transplantation include increased utilization of kidneys with less-than-ideal characteristics (4,5). One such characteristic is variant renal vascular anatomy, because over one-quarter of the population has supernumerary renal arteries (6). Concerns around the use of multiartery kidneys include the potential need for vascular reconstruction, extended cold ischemia, and implantation warm ischemia due to more complex back-table preparation and implantation, and a potential increased risk of early adverse outcomes, such as graft thrombosis (7–11). We sought to determine the association between the presence of multiple renal arteries and delayed graft function (DGF) and early graft failure after deceased donor kidney transplantation.

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Materials and Methods

We conducted a single-center retrospective cohort study to examine the association between the presence of multiple renal arteries and DGF and early graft failure after deceased donor kidney transplantation. This study was approved by the Columbia University Irving Medical Center Institutional Review Board. All clinical and research activities associated with this study were consistent with the principles of the Declaration of Istanbul.

This study utilized a previously compiled continuous retrospective cohort of all single-organ deceased donor kidneys transplanted at our center from 2006 to 2016 that had procurement biopsies reported (n=1012 kidneys from 843 donors) (Figure 1). All donor charts, including anatomy data used in this study, were reviewed as part of data collection for a prior study about procurement biopsies (12). Further identification of all transplanted partner kidneys from these donors resulted in a cohort of 1480 transplanted kidneys. Excluding those with missing data resulted in a total of 1443 kidneys from 832 unique deceased donors that were included in the primary analysis (Figure 1). Of these, 1124 (78%) had one donor renal artery and 319 (22%) had multiple arteries (277 with two arteries, 39 with three arteries, and three with four arteries, Supplemental Table 1).

Each donor’s kidney anatomy sheet was manually reviewed to obtain the number of arteries for each kidney. All other data were obtained from the Organ Procurement and Transplantation Network Standard Transplant Analysis and Research, file 2020 Q1. The data reported here have been supplied by the United Network for Organ Sharing as the contractor for the Organ Procurement and Transplantation Network. The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as an official policy of or interpretation by the Organ Procurement and Transplantation Network or the US Government.

Recipients were classified as receiving “preemptive” transplants if they did not receive pretransplant dialysis. Recipients were classified as having high panel reactive antibody if any reported panel reactive antibody value (initial, peak, or end) was ≥80%. Kidneys were classified as “imported” if they were transplanted outside of the recovering organ procurement organization.

For an exploratory analysis of the effect of multiartery anastomosis technique on early post-transplant outcomes, we reviewed the operative notes for all kidneys included in the analysis that were transplanted at our center. Anastomosis groups were defined as: (1) one artery, where the kidney had one renal artery; (2) common patch, where the kidney had multiple renal arteries that were on a common patch used for anastomosis; (3) single anastomosis, where multiple renal arteries were spatulated to create a single orifice used for anastomosis; and (4) other multiartery, covering all other kidneys with multiple renal arteries on the kidney anatomy sheet, including those with a combination of anastomosis techniques and those whose operative reports were not available, or were missing information on how the multiple renal arteries were treated.

DGF was defined by a transplant recipient receiving dialysis within the first post-transplant week. The 90-day graft failure was defined as graft failure within 90 days of transplant censored for death, the threshold used by the Organ

![Flow diagram of study cohort](https://example.com/diagram.png)

Figure 1. | Flow diagram of study cohort. After excluding transplants with missing data, 1443 kidneys were included in the primary analysis, and 324 kidneys were included in the secondary analysis.
Procurement and Transplantation Network for candidate waiting time reinstatement after early graft failure (13).

Statistical Analysis

For the primary analysis, donor, recipient, and transplant characteristics for kidneys with one artery versus multiple arteries were compared using Wilcoxon rank sum and chi-squared tests for continuous and categorical variables, respectively. Logistic regression was used to calculate the odds ratio of multiple arteries versus one artery for two outcomes of interest: DGF and 90-day graft failure, before and after adjusting for donor, recipient, and transplant characteristics. Adjusted model covariates were chosen a priori on the basis of clinical significance. Unadjusted death-censored graft survival was then assessed using the Kaplan–Meier method and log-rank test. However, adjusted survival analyses were not performed due to violations of the proportional hazards assumption.

We next performed a sensitivity analysis comparing the proportion of kidneys with ≥3 arteries (n=42) versus one artery that experienced DGF or 90-day graft failure. Given the small number events for these outcomes, logistic regression analysis was not repeated in this sensitivity analysis.

Given prior data on an increased likelihood of deceased donor kidney discard when multiple undesirable organ/donor characteristics are present, we were concerned that our primary analysis was susceptible to selection bias if kidneys with multiple arteries from marginal donors were less likely to be transplanted (4,14). Therefore, to examine the association between number of arteries and post-transplant outcomes among kidneys with balanced donor characteristics, we performed a secondary analysis limited to transplanted kidney pairs from a single donor in which one kidney had a single artery and the other had multiple arteries. After excluding pairs in which ≥1 kidney had missing data, 324 kidneys from 162 donors were included in this secondary analysis (Figure 1). The same statistical procedures performed in the primary analysis were repeated with this cohort, except for adjusted analyses for 90-day graft failure, given the cohort had <8 events for both groups combined.

Finally, for an exploratory analysis of the effect of multi-artery anastomosis technique on early post-transplant outcomes, the proportion of transplants in each group experiencing DGF and 90-day graft failure were compared using chi-squared tests. Additional analysis including logistic regression were not performed due to a high degree of incomplete data (about half of transplants were categorized as “other multiartery”) and the high likelihood of selection bias affecting which anastomosis technique was chosen for each patient.

All analyses were performed using Stata MP 15 (StataCorp, College Station, TX). Statistical significance was identified by a two-sided α<0.05.

Results

Primary Analysis

A total of 1443 kidneys from 832 deceased donors were included in the primary analysis (Figure 1), of which 1124 (78%) had a single renal artery and 319 (22%) had multiple arteries (277 with two arteries and 42 with ≥2 arteries, with similar distributions by laterality) (Supplemental Table 1). There were no significant differences in any donor characteristics between groups (Table 1). Similarly, there were no significant differences between recipients of kidneys with multiple arteries versus one artery.

Kidneys with multiple arteries experienced greater cold ischemia time at transplantation (median 34.0 hours, interquartile range [IQR], 24.0–38.5 versus 31.0 hours, IQR, 20.6–38.4, P=0.005 (Table 1). However, there was no significant difference in the incidence of DGF (multiple arteries 50%, single artery 45%, P=0.07), or in the proportion experiencing 90-day graft failure (3% in both groups). Graft failure due to thrombosis occurred in six (0.5%) single-artery kidneys and one (0.3%) multiartery kidney.

Having multiple arteries was not associated with higher odds of DGF or 90-day graft failure in logistic regression models before or after adjusting for covariates (Table 2). Unadjusted long-term death-censored graft survival (log-rank P=0.25) appeared similar over time, but adjusted analyses were not performed due to a violation of the proportional hazards assumption (Figure 2).

A sensitivity analysis comparing only kidneys with ≥3 arteries (n=42) with those with one artery demonstrated no significant differences in the proportion of transplants experiencing either of the outcomes of interest, although these comparisons were limited by small numbers of events (Supplemental Table 2). The small number of transplants with each outcome also precluded conducting adjusted analysis comparing outcomes for these groups.

Secondary Analysis: Kidney Pairs

Given the concern for residual confounding regarding which multiartery kidneys were transplanted, we next identified a subset of 162 deceased donors with two transplanted kidneys, of which only one had multiple arteries, after excluding kidneys from donors without two transplanted kidneys with fully available data or from donors with two single-artery or two multiartery kidneys (Figure 1). Among these pairs, there were no differences in characteristics between recipients of the single-artery versus multiartery kidney (Table 1). However, median cold ischemia time at transplant was 7.4 hours longer for kidneys with multiple arteries (33.5 hours, IQR, 24.0–39.0 versus 26.1, IQR 17.3–36.1, P<0.001). Multiartery kidneys were also more likely to be imported (72% versus 59%, P=0.02) and pumped before transplantation (90% versus 78%, P=0.01).

There was again no significant difference in the proportion of transplants in each group experiencing DGF (multiple arteries 48%, single artery 41%, P=0.22) or 90-day graft failure (4% versus 1%, P=0.28) (Table 1, Table 2). No kidneys in either group experienced graft failure due to graft thrombosis, although four of eight graft failure causes were listed as “Other.” Again, long-term death-censored graft-survival (log-rank P=0.67) appeared similar, but violation of the proportional hazards assumption precluded conducting adjusted analyses (Figure 2).

Exploratory Analysis: Anastomotic Technique

Among 319 kidneys with multiple renal arteries in the primary analysis, 114 (36%) had the arteries on a common patch that was used for anastomosis, whereas 53 (17%)
Table 1. Donor, recipient, and transplant characteristics of 1443 deceased donor kidneys included in the primary analysis and 162 transplanted kidney pairs included in the secondary analysis, by number of donor renal arteries

| Characteristics                  | Primary Cohort, Median (Interquartile Range) or n (%) | Paired Kidney Cohort, Median (Interquartile Range) or n (%) | P Value |
|----------------------------------|------------------------------------------------------|-------------------------------------------------------------|---------|
|                                  | n=1443 (100%)                                        | n=162 (50%)                                                |         |
| Age, yr                          | 47 (36–54)                                           | 47 (36–54)                                                 | 0.57    |
| Sex, F                           | 606 (42)                                             | 70 (43)                                                    |         |
| Race, White                      | 932 (65)                                             | 106 (65)                                                   |         |
| History of diabetes              | 217 (15)                                             | 20 (12)                                                    |         |
| History of hypertension          | 621 (43)                                             | 67 (41)                                                    |         |
| Final creatinine, mg/dl          | 1.4 (0.9–2.4)                                        | 1.2 (0.8–2.1)                                              |         |
| Donor after cardiac death        | 109 (8)                                              | 38 (12)                                                    |         |
| Kidney donor risk index          | 1.39 (1.13–1.66)                                     | 1.35 (1.11–1.59)                                           |         |
| Sex, F                           | 606 (42)                                             | 70 (43)                                                    |         |
| Race, White                      | 932 (65)                                             | 106 (65)                                                   |         |
| History of diabetes              | 217 (15)                                             | 20 (12)                                                    |         |
| History of hypertension          | 621 (43)                                             | 67 (41)                                                    |         |
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| Donor after cardiac death        | 109 (8)                                              | 38 (12)                                                    |         |
| Kidney donor risk index          | 1.39 (1.13–1.66)                                     | 1.35 (1.11–1.59)                                           |         |
| Cold ischemia time, h            | 31.4 (21.5–38.5)                                     | 26.1 (17.3–36.1)                                           | <0.001  |
| Transplant characteristics       |                                                      |                                                             |         |
| Kidney pumped                    | 1243 (86)                                            | 127 (78)                                                   | 0.01    |
| Cold ischemia time, h            | 31.4 (21.5–38.5)                                     | 26.1 (17.3–36.1)                                           | <0.001  |
| HLA mismatches                   | 5 (4–5)                                              | 5 (4–5)                                                    | 0.44    |
| Imported                         | 1029 (71)                                            | 96 (59)                                                    | 0.02    |
| Transplant outcomes              |                                                      |                                                             |         |
| Delayed graft function           | 664 (46)                                             | 66 (41)                                                    | 0.22    |
| 90-day graft failure             | 47 (3)                                               | 2 (1)                                                      | 0.28*   |

F, female; PRA, panel reactive antibody.
*Tested using Fisher’s exact test.

Discussion

Deceased donor kidney utilization remains suboptimal in the United States, despite a severe organ shortage, with the majority of discards and declined organ offers attributed to organ and donor characteristics (4,15). Improving kidney utilization therefore depends on better elucidating the associations between less-than-ideal donor/organ traits and post-transplant outcomes. In this study, we found that transplantation using deceased donor kidneys with multiple renal arteries was not associated with increased odds of DGF or 90-day graft failure despite longer pretransplant cold ischemia time.

In our cohort, 23% of transplanted kidneys had multiple arteries. We found that kidneys in the primary analysis with multiple arteries had significantly longer cold ischemia time at transplant than those with one artery, despite having similar organ quality as assessed by individual donor characteristics and kidney donor profile index (KDPI). Strikingly, in the analysis of kidney pairs, multivariety kidneys had a median cold ischemia time >7 hours longer than their single-artery mate kidneys, and were more likely to be imported, despite both groups sharing the same donor pool. These findings suggest reluctance of certain centers to accept multivariety kidney offers, and augment prior research showing that anatomic abnormalities

had the multiple arteries spatulated to form one orifice for a single anastomosis. The remaining 152 (48%) (“other multivariety”) either used a combination of techniques (n=9), multiple anastomosis (n=2), polar artery ligation (n=3), or hadoperative reports that were unavailable for us to review, or lacked information about how multiple renal arteries were treated (n=138). The proportion of transplant experiencing DGF was highest among the single anastomosis group (66%), but similar among other groups (P=0.02 for difference between groups, Table 3). The proportion of transplants experiencing 90-day graft failure was 3%–4% among all groups. Unadjusted death-censored graft-survival was lowest for the single anastomosis group (log-rank P=0.001 for comparison across groups) (Figure 3).

Among 162 kidneys with multiple renal arteries in the secondary paired kidney analysis, 52 (32%) used a common patch, 28 (17%) used a single anastomosis, and 82 (51%) were other multivariety kidneys. Although the differences in DGF between groups were similar to those seen in the primary cohort, these differences were not statistically different in the paired kidney cohort (Table 3). There was also no significant difference in unadjusted death-censored graft-survival between groups (log-rank P=0.20) (Figure 3).
are a relatively frequent reason for discard of high-quality organs (16). This reluctance and the resulting extended ischemia decrease allocation efficiency and likely further increase the risk of discard (4). Further, the associated increase in pumping we observed carries higher financial costs. Although arterial reconstruction necessitates extended cold ischemia (11), this alone is unlikely to explain the magnitude of the differences in cold ischemia time we observed.

"Fast-track" strategies to expedite placement of organs with these or other anatomic abnormalities to centers that have shown a greater willingness to transplant them may reduce their ischemia times and increase overall utilization (17,18). The implementation of such a system in the United Kingdom led to stabilization of rising kidney discard rates (17). However, center-level allocation may meet resistance in the United States, given that allocation rules require kidneys to be allocated at the patient level (19). Simulations of an alternative simultaneously expiring offer strategy in the United States suggest that faster organ placement and a reduction in discards may be achieved through this mechanism as well (20). However, determining the best kidneys to include in any of these alternative allocation schemes requires more robust data collection to identify the characteristics most likely to lead to organ offer refusal. Although we infer greater unwillingness to accept multiartery kidneys for transplant on the basis of their longer cold ischemia time and higher proportion of imported transplants, we lack direct evidence that renal artery number was the primary reason for organ offer refusal. Current offer refusal codes lack granular options to study such an effect, and improving the quality of these data may help identify which organ characteristics—such as arterial anatomy—warrant special allocation strategies.

Table 2. Logistic regression models assessing the relationship between number of donor renal arteries and early post-transplant outcomes in the primary and paired kidney cohorts

| Outcome                        | Unadjusted   | Adjusted*               |
|--------------------------------|--------------|-------------------------|
|                                | Odds Ratio   | 95% Confidence Interval | P Value | Odds Ratio   | 95% Confidence Interval | P Value |
| Multiple arteries versus single artery, primary cohort |             |                         |         |             |                         |         |
| DGF                            | 1.26         | 0.98 to 1.61            | 0.07    | 1.23         | 0.95 to 1.61            | 0.12    |
| 90D GF                         | 1.08         | 0.54 to 2.15            | 0.83    | 1.12         | 0.56 to 2.25            | 0.75    |
| Multiple arteries versus single artery, paired kidney cohort |             |                         |         |             |                         |         |
| DGF                            | 1.32         | 0.85 to 2.05            | 0.22    | 1.16         | 0.72 to 1.87            | 0.53    |
| 90D GF                         | 3.08         | 0.61 to 15.48           | 0.17    | Not performed|                         |         |

DGF, delayed graft function; 90D GF, 90-day graft failure, PRA, panel reactive antibody.

*Adjusted models include donor kidney donor risk index, recipient race, recipient preemptive status, recipient prior transplant, recipient sex, recipient high PRA status, recipient diabetes, cold ischemia time, and number of human leukocyte antigen mismatches.
those seen elsewhere, and the attendant very high incidence of DGF we observed in both groups may be responsible for our findings. It is also possible that factors such as an increased use of perfusion pumps in the multiartery group helped attenuate this difference, or there is a small difference that we lack the power to detect.

Two large French studies previously described higher rates of vascular complications in deceased donor transplant using kidneys with multiple arteries (7,10). In the largest, Bessede and colleagues reported that in a series of 3129 transplants, including 728 kidneys with multiple arteries, those with multiple arteries were three times more likely to experience arterial thrombosis after transplantation (4% versus 1%) (10). However, these counts included kidneys with multiple anastomoses for which only the polar artery thrombosed, an event that may be clinically significant, depending on supernumerary arterial anatomy. We found no significant difference in 90-day graft failure in either cohort, although our paired kidney analysis was underpowered to study this outcome. Given the high proportion of anastomosis in our cohort categorized as “other multiartery” in our cohort, it is possible variations in surgical practices explain the difference between our findings and those of others. Several investigators have studied the effect of multiple arteries on living donor kidney transplant outcomes and found no effect on short-term graft survival or function (8,9,22–25). One study of 60 living donor transplants (25 multiartery) in Poland found no difference in DGF or 1-year creatinine between living donor allografts with one versus multiple arteries, results that were similar to an earlier study of 510 transplants (117 multiartery) in the United States that showed no difference in DGF, vascular/urologic complications, or graft survival (22,23). However, the applicability of these data to deceased donor kidney decision making is not clear, given differences in donor age/comorbidities, cold ischemia time, and vessel quality. In two series with 43 and 62 kidneys with ≥3 renal arteries, these kidneys experienced higher rates of DGF and vascular and urologic complications—albeit similar allograft function at 1 year—suspected to be in part due to longer warm and cold ischemia time observed (8,24). Although we did not find an effect of ≥3 arteries on any early post-transplant outcomes, a small number of events limits the power of these analyses. Unfortunately, almost half of the failed kidneys in our cohort had graft failure causes that were missing or attributed to “Other,” limiting our ability to determine the association between multiple arteries and specific transplant.

| Table 3. Proportion of transplants experiencing delayed graft function and 90-day graft failure, by renal artery anastomosis technique |
|---------------------------------------------------------------|
| **Outcome** | **Primary Cohort** | **Paired Kidney Cohort** |
| | **Incidence** | **P Value** | **Incidence** | **P Value** |
| **Delayed graft function** | | | | |
| One artery | 503/1124 (45%) | 0.02 | 66/162 (41%) | 0.25 |
| Common patch | 58/114 (51%) | | 22/52 (42%) | |
| Single anastomosis | 35/53 (66%) | | 17/28 (61%) | |
| Other multiartery | 68/152 (45%) | | 38/82 (46%) | |
| **90-day graft failure** | | | | |
| One artery | 36/1124 (3%) | 0.77<sup>a</sup> | 2/162 (1%) | 0.34<sup>a</sup> |
| Common patch | 5/114 (4%) | | 2/52 (4%) | |
| Single anastomosis | 2/53 (4%) | | 1/28 (4%) | |
| Other multiartery | 4/152 (3%) | | 3/82 (4%) | |

<sup>a</sup>Tested using Fisher’s exact test.
failure mechanisms. We also lack capture of events such as partial graft thrombosis that did not lead to graft failure.

Our dataset lacks detailed information on the anatomy of the multiple arteries and, for a large proportion of kidneys, the vascular surgical techniques used during implantation, each of which may affect outcomes independently or via prolonged implantation warm ischemia (26). In prior studies among living donor transplants with multiple arteries, those that underwent reconstruction had longer warm ischemia time and more frequent ureteral complications, compared with those in which a polar artery was ligated (9). We observed that kidneys with multiple renal arteries that were spatulated for a single anastomosis had higher incidence of DGF in the primary analysis cohort, but otherwise had similar 90-day graft failure. However, our results and those of others should be interpreted with caution, given it is most likely there is a high likelihood of selection bias affecting which anastomosis technique was chosen for each patient, and very few kidneys in our study had multiple anastomosis or polar artery ligation (only two and three, respectively). Further study of whether one anastomotic technique is superior to others in the setting of multiple feasible options will require detailed capture of artery size and relative location, and the inclusion of transplants using a more diverse set of anastomosis techniques.

Strengths of our study include a large sample size, and a novel paired kidney analysis that allows the comparison of kidneys with multiple versus single arteries when donor factors are held constant. Limitations include possible residual confounding and selection bias due to its retrospective nature. In particular, kidneys with multiple arteries may be more susceptible to discard in the presence of other undesirable donor or organ characteristics. Further, our paired kidney analysis is limited by a small number of events for 90-day graft failure. Importantly, we also lack information about post-transplant differences in kidney function or blood pressure between groups. It is possible that delayed vascular complications, such as renal artery stenosis, can affect these outcomes (10). It is also possible that lower nephron mass may affect kidney function in patients where small polar arteries are ligated. We also lack data on urologic complications that may be more frequent after arterial reconstruction or ligation. Better capture of these elements in national registries can help improve our understanding of how to best manage grafts with multiple arteries. Finally, the incidence of DGF is higher than the national average at our center, and therefore in our cohort, kidneys with multiple versus single arteries had longer cold ischemia time.

In conclusion, deceased donor kidney transplants using kidneys with multiple renal arteries had longer cold ischemia times but similar early post-transplant outcomes compared with those with one artery. Systematic capture of renal vascular anatomy and surgical technique in national registries may help better elucidate any effect of supernumerary renal arteries on post-transplant outcomes.

Disclosures

J. Adler reports being a scientific advisor or member of CareDx; reports receiving research funding from Angion Biomedica; reports being a scientific advisor or member of the Angion Pharma scientific advisory board, Deputy Editor of Kidney International Reports (International Society of Nephrology), Member of the American Society of Nephrology Quality committee, Member of the Scientific Registry of Transplant Recipients Visiting Committee, Vice Chair of the United Network for Organ Sharing Data advisory committee; and reports receiving research funding from the National Institute of Diabetes and Digestive and Kidney Diseases (DK114893, DK126739 and DK116066) and the National Institute of Minority Health and Health Disparities (MD014161). S. Husain reports receiving research funding from NCATS; and reports receiving honoraria from the Renal Research Institute. All remaining authors have nothing to disclose.

Funding

This work was supported by the National Center for Advancing Translational Sciences (KL2 TR001874 to S. Husain). This work was supported in part by Health Resources and Services Administration contract 234-2005-37001C.

Acknowledgments

The content is the responsibility of the authors alone and does not necessarily reflect the views or policies of the Department of Health and Human Services, nor does mention of trade names, commercial products, or organizations imply endorsement by the US Government.

Author Contributions

J. Adler, S. Husain, and S. Mohan conceptualized the study; S. Husain and S. Robbins-Juarez were responsible for the data curation; S. Husain was responsible for the formal analysis; J. Adler, S. Husain, K. King, K. McCune, S. Mohan, and S. Robbins-Juarez were responsible for the investigation; J. Adler, S. Husain, K. King, K. McCune, and S. Mohan were responsible for the methodology; S. Mohan provided supervision; S. Husain wrote the original draft; and J. Adler, K. King, K. McCune, S. Mohan, and S. Robbins-Juarez reviewed and edited the manuscript.

Data Sharing Statement

Data are available upon reasonable request to the corresponding author.

Supplemental Material

This article contains the following supplemental material online at http://kidney360.asnjournals.org/lookup/suppl/doi:10.34067/KID.000152021/-/DCSupplemental.

Supplemental Table 1. Counts of (A) kidneys with each number of donor renal arteries (B) and distribution of right versus left donor arteries among donors with bilateral anatomy reported in the primary cohort.

Supplemental Table 2. Sensitivity analysis of early post-transplant outcomes among deceased donor kidneys with at least three renal arteries versus those with a single renal artery in the primary cohort.

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