

# Outcome of Kidney Transplantation From Living Donors With Multiple Renal Arteries Versus Single Renal Artery

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**Introduction.** Receiving a kidney transplant from donors with multiple renal arteries (MRAs) is suggested to be associated with higher risk of vascular and urologic complications and poor allograft outcomes compared to the donors with single renal artery (SRA). We evaluated survival rates in the recipients from donors with MRAs compared to those from donors with SRA.

**Materials and Methods.** In a retrospective study on 115 kidney allograft recipients, demographic characteristics and the outcomes of kidney transplantation were compared between the recipients from donors with MRAs compared to those from donors with SRA. These included acute tubular necrosis, acute allograft rejection, hypertension, vascular complications, urologic complications, kidney function indicators, and allograft survival at 1 year.

**Results.** There was no significant difference in the recipients' age, sex distribution, and weight, donors' age, donor-recipient familial relation, urologic complications, and duration of hospitalization between the two groups. However, MRA was significantly associated with a higher likelihood of right-side kidney donation, longer warm and cold ischemia times, and lower glomerular filtration rate and higher serum creatinine concentrations at discharge and 12 months after transplantation, as compared to SRA transplants. No significant difference was seen in late complications including hypertension and renal artery stenosis. One-year graft survival was slightly poorer in the MRA group than the SRA group.

**Conclusions.** Our results demonstrate that kidney allografts with MRAs are associated with risks but have acceptable outcomes during the 1st year after transplantation, as compared to SRA kidney allografts.

## INTRODUCTION

Kidney transplantation is the treatment of choice for many patients with end-stage renal disease, improving both the patient's longevity and quality of life.<sup>1</sup> Kidney transplantation has been always a challenge for surgeons when anatomic variations exist, since vascular and urologic complications may

occur more often in these transplants.<sup>2,3</sup> The most common variation is donor kidneys with multiple renal arteries (MRAs). This is observed in 8% to 30% of the donors.<sup>4,5</sup> Although kidney allografts with MRAs lead to donor pool expansion, they may be associated with other complications such as increased time of warm ischemia, acute rejection,

acute tubular necrosis, and vascular thrombosis.<sup>6</sup>

Some recent studies have shown that there are no differences in survival and complications between the kidneys with single renal artery (SRA) and MRAs.<sup>4</sup> However, there still are controversies. We evaluated survival rates in the recipients of kidney transplants from donors with MRAs compared to kidney transplant recipients from donors with SRA in a retrospective study.

## MATERIALS AND METHODS

This retrospective study was performed at Emam Khomeini Hospital of Urmia University of Medical Sciences from 2010 to 2012. One-year post transplant results of a 1st transplantation from living donors with more than 1 main renal artery in the vascular map were compared with 1st transplantation from donors with SRA. All of the recipients had negative panel reactive antibodies.

In addition to baseline laboratory tests, renal computed tomographic angiography were performed in the participating candidates for kidney transplantation in order to obtain the renal vascular map as guidance for the surgeon at the time of anastomosis of the graft vessels. For computed tomographic angiography, 100 mL of low osmolar contrast (omnipaque, 350 mg/dL) was injected with the rate of 3 mL/s to 5 mL/s. Renal image was taken 1 to 2 minutes later at the time of initiation of renal perfusion, in order to visualize the arterial phase and anatomy of the renal arteries, nephrogram phase, excretory phase, and appearance of the contrast material in ureters and ultimately renal venous system. Accessory vessels of the superior and inferior poles of the kidneys could be also detected in this method.

One surgery team performed all of the kidney transplantations after donor nephrectomy by establishing incision in donor's flank region. The transplant recipients were divided into 2 groups based on the number of renal arteries of the allograft (SRA and MRAs). Induction therapy in all of the patients was triple therapy with cyclosporine, 6 mg/kg, mycophenolate mofetil, 1000 mg per 12 hours, and methylprednisolone pulse, 15 mg/kg for 3 days. The effect of age and sex of the recipients and the donors on MRA and SRA allograft outcome were assessed. The two groups were also compared in terms of the duration of stay at hospital after transplantation; warm and cold ischemia time;

the occurrence of acute tubular necrosis (clinical diagnosis); delayed graft function; recipient's serum creatinine and glomerular filtration rate (GFR; estimated using the Cockcroft-Gault equation) at the time of discharge from hospital and at 1, 3, 6, 9, and 12 months after transplantation; acute rejection (clinical diagnosis early after transplantation and pathology proven diagnosis late after transplantation); urologic complications; hypertension; and graft artery stenosis (according to color Doppler ultrasonography).

Data were analyzed using the SPSS software (Statistical Package for the Social Sciences, version 13.0, SPSS Inc, Chicago, Ill, USA). The Pearson chi-square test, Fisher exact test, independent sample *t* test, and Mann-Whitney test were applied for comparisons. The Kaplan-Meier method was utilized to evaluate 1-year allograft and patient survival. A *P* less than .05 was considered significant.

## RESULTS

A total of 115 kidney allograft recipients were enrolled to this study. They were 59 men (51.3%) and 56 women (48.7%). Forty-two recipients (36.5%) had allografts with MRAs; they were 25 men (59.5%) and 17 women (40.5%). Seventy-three recipients (63.5%) had allografts with SRA; they were 34 men (46.6%) and 39 women (53.4%). The mean age of the recipients was  $37.9 \pm 14.5$  years in the MRA group and  $37.1 \pm 11.0$  years in the SRA group (*P* = .73). No differences were observed in the demographic characteristics between the two groups (Table 1).

Table 2 summarizes the kidney transplantation characteristics and outcomes. Among 115 donors, the left kidney was selected for donation in 83 individuals (72.2%) and the right kidney in 32 individuals (27.8%). In the MRA group, 20 patients (47.6%) received a donor's left kidney and 22 (52.4%) received a right kidney, while in the SRA group, 63 (86.3%) received a left kidney and 10 (13.7%) received a right kidney (*P* < .001). The mean cold and warm ischemia times were significantly longer in the MRA group as compared with the SRA group (Table 2). Acute tubular necrosis occurred in 14 recipients (33.3 %) in the MRA group and in 13 (17.8%) in the SRA group (*P* = .06). Urologic complications occurred in 10 recipients (23.8%) of the MRA group and in 26 (35.6%) of the SRA group (*P* = .19). During the 1-year follow-up period,

**Table 1.** Characteristics of Recipients and Donors of Kidney Allografts With Single and Multiple Renal Arteries\*

Characteristic	Kidney Allograft Recipients		P
	Single Renal Artery (n = 73)	Multiple Renal Arteries (n = 42)	
Recipients' sex			
Male	34 (46.6)	25 (59.5)	
Female	39 (53.4)	17 (40.5)	.18
Recipients' age, y	37.1 ± 11.0	37.9 ± 14.5	.73
Recipients' body weight, kg	57.5 ± 11.7	56.4 ± 13.1	.66
Donors' age, y	27.8 ± 6.0	28.9 ± 6.0	.32

\*Values are mean standard deviation for continuous variables and frequency (percentage) for categorical variables.

**Table 2.** Characteristics and Outcomes of Kidney Transplantations in Recipients of Kidney Allografts With Single and Multiple Renal Arteries\*

Characteristic	Kidney Allograft Recipients		P
	Single Renal Artery (n = 73)	Multiple Renal Arteries (n = 42)	
Side of kidney allograft			
Left	63 (86.3)	20 (47.6)	
Right	10 (13.7)	22 (52.4)	< .001
Living related transplantation	5 (6.8)	5 (11.9)	.49
Warm Ischemia, min	2.6 ± 1.2	3.5 ± 2.3	.03
Cold Ischemia, min	21.5 ± 9.4	27.3 ± 11.2	.004
Urologic complications	26 (35.6)	10 (23.8)	.19
Acute tubular necrosis	13 (17.8)	14 (33.3)	.06
Renal artery stenosis	1 (1.4)	0	> .99
Hypertension	58 (79.5)	29 (69.0)	.21
Length of hospital stay, d	25.1 ± 6.6	27.5 ± 9.6	.16
Serum creatinine at discharge, mg/dL	1.1 ± 0.3	1.5 ± 0.9	.009
Glomerular filtration rate at discharge, mL/min	75.3 ± 30.0	61.2 ± 27.1	.03
Acute allograft rejection during 12 months	27 (37.0)	21 (50.0)	.24
Number of rejections during 12 months*			
1	23 (31.5)	16 (38.1)	
2	6 (8.2)	7 (16.7)	
3	2 (2.7)	0	
4	0	1 (2.4)	.11

\*Values are mean standard deviation for continuous variables and frequency (percentage) for categorical variables.

hypertension was observed in 29 recipients (69.0%) of the MRA group and in 58 (79.5%) of the SRA group ( $P = .21$ ). Renal allograft artery stenosis did not occur in the MRA group and occurred in 1 recipient (1.4%) of the SRA group ( $P > .99$ ). The total number of acute allograft rejections during 12 months after transplantation was 21 (50.0%) in

the MRA group and 27 (37.0%) in the SRA group ( $P = .24$ ). During the first year after transplantation, the two groups were not significantly different in terms of number of acute rejections occurred in each recipient, either ( $P = .11$ ). Logistic regression model did not show any other significant predictors of the number of acute rejections (Table 3).

**Table 3.** Logistic Regression Model for Acute Allograft Rejection Counts After Kidney Transplantation

Variable	Odds Ratio (95% Confidence Interval)	P
Kidney allograft with multiple renal arteries	1.482 (0.587 to 3.743)	.41
Male sex	0.834 (0.367 to 1.895)	.66
Age	0.987 (0.955 to 1.021)	.45
Baseline serum creatinine	2.193 (0.679 to 7.08)	.19
Kidney Side	0.699 (0.268 to 1.824)	.46
Living related transplantation	2.225 (0.465 to 10.658)	.32

**Table 4.** Estimated Mean Glomerular Filtration Rates During 12 Months After Transplantation in Recipients of Kidney Allografts With Single and Multiple Renal Arteries

Glomerular Filtration Rate, mL/min	Kidney Allograft Recipients		P
	Single Renal Artery (n = 73)	Multiple Renal Arteries (n = 42)	
Baseline	76.3 ± 19.3	60.5 ± 24.2	< .001
Month 1	76.7 ± 25.4	61.9 ± 26.7	.005
Month 2	77.2 ± 24.8	65.2 ± 26.3	.02
Month 3	79.1 ± 25.5	67.9 ± 30.0	.05
Month 6	81.5 ± 29.2	78.5 ± 27.4	.64
Month 9	80.8 ± 26.5	73.2 ± 28.5	.22
Month 12	81.8 ± 31.3	64.8 ± 27.7	.01

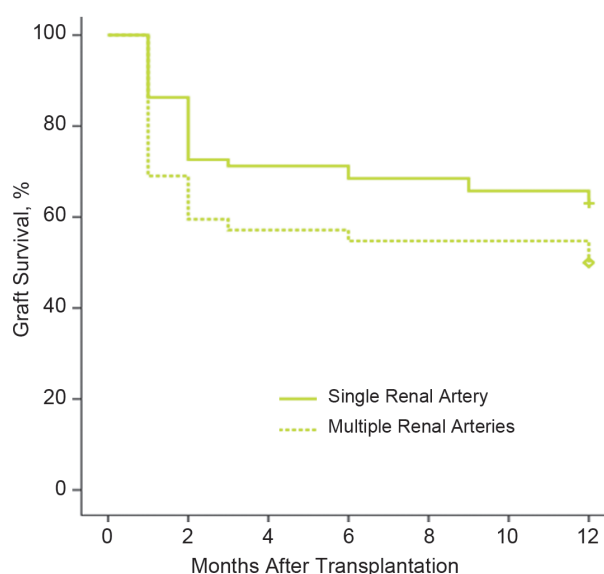
Serum creatinine at discharge from hospital was  $1.50 \pm 0.92$  mg/dL in the recipients of the MRA group and  $1.10 \pm 0.26$  mg/dL in those of the SRA group ( $P = .009$ ). The estimated GFR showed a similar significant difference between the two groups ( $P = .03$ ; Table 2). Comparisons of the GFRs calculated at baseline and monthly during the first indicated a significantly better preservation of kidney function in the SRA group (Table 4). However, no significant difference was observed in allograft survival rates between the two groups using the linear log test ( $P = .12$ ; Figure).

## DISCUSSION

In theory, donated kidneys with MRAs may be associated with higher possibilities of ischemia, acute tubular necrosis, and acute graft rejection. There is still much debate on this issue. Rezaei and colleagues showed that 1-year graft survival was

97.4% when transplant was received from a related donor and 85.6% when received from unrelated donor, the difference of which was significant.<sup>3</sup> In Aydin and coworkers' study, the rate of 1-year graft survival was 93% in transplants with MRAs and 95% in those with SRA.<sup>4</sup> In Porooshani and colleagues' study,<sup>7</sup> 1-year graft survival of kidneys from related and unrelated donors were 100% and 89.4%, respectively. Significant association was observed between the rate of graft survival and weight and age of donors, sex of recipient, familial relationship between donor and recipient, the side of donated kidney, and surgical complications; however, graft survival did not differ between the two sexes.

Mazzucchi and coworkers<sup>8</sup> investigated the incidence of surgical complications such as vascular, urologic and lymphocele and found that those were comparable between kidney transplants of SRA and MRA kidney allografts. Also, the rate of delayed graft function and serum creatinine level 1 year after transplantation were not significantly different. In Gawish and colleagues' study,<sup>9</sup> 1-year graft survival was 94.3% in their MRA group and 93.7% in the SRA group, but complications such as hemorrhage around the graft and thrombosis of the renal artery and renal vein were more frequent in the MRA group. They concluded that graft survival of allografts with MRAs was not so different from the allografts with SRA, and the complications were only slightly more common with MRA. In another study, the rate of graft survival was reported 92.3% in the SRA group and 91.3% in the MRA group with no significant difference.<sup>10</sup> In this study, renal artery stenosis in the MRA group and SRA group were 0.1% and 1.3%, respectively; the difference was not found to be significant.<sup>10</sup> In our study, there was no significant difference in



Graft survival for recipients of kidney allografts with single renal artery versus multiple renal arteries.

the rate of graft survival between the two groups, and no specific factor was found to be related to graft survival. The incidence rates of renal artery stenosis, acute allograft rejection, and hypertension were similar, too. The incidence of acute tubular necrosis was, however, higher in the MRA group, but the difference was not significant ( $P = .06$ ).

In another report, 1-year graft survival was 94.4% in the recipients of MRA kidney allografts and 89.6% in those of SRA kidney allografts in another study, and acute rejection in the MRA group was 2 times more likely than in the SRA group.<sup>11</sup> This study also demonstrated that posttransplant GFR was significantly lower in the MRA group compared to the SRA group.<sup>11</sup> Kamali and colleagues,<sup>12</sup> however, observed no significant difference in acute graft rejection rates between their two groups. Renal allograft artery stenosis was seen in 8.3% in the MRA group and 5.9% in the SRA group in their study with a significant difference. One-year graft survival was 93.6% in the MRA group and 96.8% in the SRA group and the difference was not significant.<sup>12</sup>

Abbaszadeh and associates<sup>13</sup> compared 3 groups of transplant recipients of kidney allografts with SRA, 2 renal arteries, and MRAs; 1-year graft survival rates were 95%, 95%, and 71%, respectively. The incidence of acute allograft rejection was significantly higher in with MRA compared to SRA. Likewise, acute rejection was more common among our MRA group, but the difference was not significant ( $P = .11$ ). Furthermore, they reported no differences in GFR between their three recipient groups,<sup>13</sup> while GFR was lower in our MRA group in the 1st posttransplant month ( $P < .001$ ) and at the end of the 1st year ( $P = .01$ ). No difference regarding acute tubular necrosis was observed in Basaran and coworkers' study of transplants with MRA and SRA.<sup>14</sup> One-year graft survival was 95.1% with SRA allografts and 95% with MRA allografts.<sup>14</sup> It seems that selecting the right- versus the left-side kidney has no effect on graft survival.<sup>15</sup>

The age of recipient and familial relationship with donor had no significant association with graft survival in our study. Other studies did not show any association between the age of recipient and graft survival either.<sup>16</sup> Survival of kidney transplant recipients has increased in recent years as a result of improving techniques and better immunosuppressive drugs.<sup>17</sup>

## CONCLUSIONS

Transplanting a kidney with MRAs has several drawbacks. In our study, there was a difference between transplants of MA and SRA kidney allografts respecting selection of the side of the donated kidney, warm and cold ischemia time, GFR, and serum creatinine levels at discharge and 12 months after transplantation. However, no significant difference was observed in late complications including hypertension and renal artery stenosis. One-year graft survival was slightly better in the SRA group. Improvement in surgical techniques and equipment has made recovery of kidney allografts with multiple arteries relatively safe; however, a more practice is necessary.

## CONFLICT OF INTEREST

None declared.

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