Section: Urology

Original Research Article

INSTITUTIONAL EXPERIENCE ON COMPARISON OF ALLOGRAFTS WITH MULTIPLE-RENAL ARTERY VS. SINGLE RENAL ARTERY IN LIVING AND DECEASED DONOR TRANSPLANTATION

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Abstract

Background: Kidney transplants from living donors generally have better outcomes than those from deceased donors. However, over time, survival rates have improved for both living and deceased donor transplantation. We assessed the postoperative complications and clinical outcomes of allografts with multiple renal arteries (MRA) vs. single renal arteries (SRA) in living and deceased donor transplantations. **Materials and Methods:** This retrospective study of 95 patients at Government Kilpauk Medical College, Chennai, analyzed postoperative complications and clinical outcomes in living and deceased donor kidney transplants. Data were collected from patient records and pre-transplant evaluations, including computed tomography renal angiography, human leukocyte antigen typing, tissue cross-matching, and ABO blood group compatibility assessment. Renal function tests, contrast-enhanced computed tomography urography, renal angiography, and diethylenetriamine pentaacetate scans were performed. **Result:** The mean age of participants was 34.65 ± 10.41 years, and the mean cold ischemia time was 77.25 ± 20.45 minutes. Of the 95 patients, 67.4% were male and 32.6% were female. 83.2% received living donor transplants and 84.2% had SRA grafts. Immediate graft function and graft survival were achieved in 88.4% and graft survival at 3 and 6 months was 98.9% of the patients, respectively. Vascular and urological complications occurred in 3.2% and 5.3% of the cases, respectively. The mortality rate due to sepsis was 3.2%. SRA grafts had fewer vascular complications than MRA grafts did (1.3% vs. 13.3%, $p = 0.014$). The mortality rate was higher in the MRA group (20.0%; $p < 0.0001$). **Conclusion:** Renal transplantation with SRA allografts yielded superior outcomes compared to MRA allografts.

INTRODUCTION

Kidney transplantation is the preferred treatment for end-stage renal disease (ESRD), as it provides better patient survival rates and quality of life than chronic dialysis. Recent advancements in immunosuppression have shifted the primary causes of allograft loss and mortality in kidney transplant recipients to non-immunological factors.[1] One of the most challenging aspects of kidney graft implantation is vascular anastomosis, which poses significant difficulties for transplant surgeons. Postoperative vascular complications, including bleeding or thrombosis, may require additional surgical procedures or even nephrectomy.[2] About 30% of kidney grafts have two or more arteries, which often leads to complex arterial reconstructions during the transplantation process.[3]

Developments in surgical techniques and immunosuppressive protocols have extended the criteria for donor selection, allowing the use of both living and deceased donors. Living-donor kidney transplantation (LDKT) has seen significant growth, increasing the number of transplants that involve kidney allografts with multiple arteries. These grafts often necessitate complex back-table reconstructions, which have been linked to less favourable post-transplant outcomes compared to single-artery allografts.[4] Nevertheless, LDKT presents several benefits over deceased donor transplantation, such as shorter waiting periods, the possibility of preemptive transplantation, the ability to plan the procedure, and generally improved graft survival rates.

Consequently, LDKT procedures have become increasingly prevalent. However, the removal and implantation of kidneys with multiple renal arteries (MRA) continue to pose technical challenges. The acceptance and management of MRA grafts for LDKT differ significantly among transplant centres, highlighting the intricacies involved in these cases.[5]

Urological complications are the most common late-stage issues in kidney transplantation, affecting between 2.5% and 12.5% of cases. These complications can lead to increased morbidity, delayed graft function, and higher hospitalization costs, primarily due to donor ureter ischemia and failure of surgical techniques. Early graft failure is typically caused by acute rejection, technical problems, or nonviable kidneys, whereas chronic failure often results from death due to non-kidney-related issues or progression to chronic kidney disease.[6] Therefore, it is essential for kidney transplant surgeons to understand the incidence, clinical manifestations, and management of surgical complications.

This study aimed to contribute to the growing body of evidence by assessing the postoperative complications and clinical outcomes of renal transplant recipients receiving multiple renal artery grafts in comparison with a single renal artery graft. The primary aim of this study was to compare urological (urine leak and stenosis) and vascular complications (renal artery and vein thrombosis) in renal allografts with a single artery vs. multiple arteries. Additionally, the secondary objectives included assessing delayed graft function and graft survival at 3- and 6-months post-transplantation.

MATERIALS AND METHODS

This retrospective analytical study was conducted at the Government Kilpauk Medical College and Hospital, Chennai, from April 2022 to April 2024. The study included 95 patients admitted to the Urology Ward for the management of End-Stage Renal Disease (ESRD).

Inclusion Criteria

Patients aged 18–65 years undergoing live and cadaveric renal transplant surgery at Govt Kilpauk Medical College and Hospital between April 2022 and April 2024.

Exclusion Criteria

Pediatric renal transplants and patients undergoing a second renal transplantation were excluded from the study.

We conducted a retrospective analysis of a cohort of consecutive kidney transplants from both living and deceased donors and compared the incidence of postoperative complications and other clinical outcomes between recipients with a single artery and those with multiple arteries. Living donors underwent evaluation through computed tomography renal angiography and human leukocyte antigen typing, and tissue crossmatching was performed between donors and recipients before transplantation. Additionally, all donors and recipients were assessed for ABO blood-group compatibility.

Surgical Technique

All transplants were performed by expert, skilled renal transplant surgeons. The standard method for donor nephrectomy is open surgery, with a preference for the left kidney, unless there are contraindications. An extraperitoneal approach was employed, and grafts were placed in the right iliac fossa. The renal vein was connected to the external iliac vein in an end-to-side fashion, whereas the renal artery was joined to the internal iliac artery in an end-to-end manner. For MRA grafts, the main artery was connected to the internal iliac artery, and additional arteries were linked to the external iliac artery using an end-to-side technique. Polypropylene sutures (Prolene 6-0) were used for the vascular connections.

In all cases, modified Lich-Gregoir ureteroneocystostomy was performed using 5-0 polyglactin (Vicryl) sutures. A double-J stent was routinely inserted. The drain was removed on the fifth postoperative day, and the urethral catheter was removed on the sixth day. Doppler ultrasonography was performed before drain removal.

Renal function tests, contrast-enhanced computed tomography (CECT) urography, renal angiography, and diethylene triamine pentaacetate (DTPA) scans were performed. Data were collected using a standardized pro forma, laboratory test results, and patient records. Postoperative complications and clinical outcomes were also analysed.

Statistical Analysis

Statistical analysis was performed using the SPSS software. Continuous variables are summarized as mean and standard deviation, while categorical variables are expressed as frequencies and percentages. Categorical variables were compared using the chi-squared test. A p-value <0.05 is considered significant.

RESULTS

The mean age of the participants was 34.65 ± 10.41 years, and the mean cold ischemia time (CIT) was 77.25 ± 20.45 minutes. Of the 95 patients, 67.4% (64) were male, and 32.6% (31) were female. The majority of transplants were from living donors (LRRT: 83.2%, 79 patients), while the remaining were deceased donor transplants (DDRT: 16.8%, 16 patients). Most patients had allografts with a single renal artery (SRA: 84.2%, 80 patients), while allografts with multiple renal arteries (MRA) were observed in 15.8% (15 patients) [Table 1].

The majority of recipients received allografts with a single renal artery (84.2%, 80 patients), while 15.8% (15 patients) had multiple renal arteries. Among the recipients, acute tubular necrosis (ATN) was observed in 10.5% (10 patients), while the majority (89.5%, 85 patients) did not develop ATN. Immediate graft function (IMGF) was achieved in

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88.4% (84 patients), and 11.6% (11 patients) showed delayed graft function.

Graft survival at 3 and 6 months was high, with 98.9% (94 patients) having a functional graft and only 1.1% (1 patient) experiencing graft failure. Vascular complications were rare, occurring in 3.2% (3 patients), and urological complications were noted in 5.3% (5 patients). Mortality was observed in 3.2% (3 patients), all of which were attributed to sepsis, while 96.8% (92 patients) survived [Table 2].

Immediate graft function (IMGF) was strongly associated with graft survival at three and six months. Among the patients with IMGF, 100% demonstrated graft survival, whereas only 90.9% without IMGF had functional grafts ($p = 0.005$). Patients with SRA had a lower incidence of vascular complications (1.3%) than those with MRA, with complications occurring in 13.3% of patients ($p = 0.014$). Urological complications were observed in 5% and 6.7% of the patients with SRA and MRA, respectively ($p = 0.791$). Mortality was significantly higher in the MRA group (20%) than in the SRA group ($p < 0.0001$) [Table 3].

Table 1: Baseline characteristics, donor type distribution, and renal artery distribution of participants.

Variables		**Mean**	**Standard Deviation**
Age		34.65	10.41
CIT		77.25	20.45
Variables		No of patients	Percentage
Sex	Female	31	32.6%
	Male	64	67.4%
LRRT	No	16	16.8%
	Yes	79	83.2%
DDRT	No	79	83.2%
	Yes	16	16.8%
SRA	No	15	15.8%
	Yes	80	84.2%
MRA	No	80	84.2%
	Yes	15	15.8%

Table 2: Clinical Outcomes and Complications

		Number of patients	**Percentage**
Number of renal arteries	Single artery	80	84.2%
	Multiple arteries	15	15.8%
ATN acute tubular necrosis	No	85	89.5%
	Yes	10	10.5%
IMGF	No	11	11.6%
	Yes	84	88.4%
Graft survival 3,6mths	No	1	1.1%
	Yes	94	98.9%
Vascular complication	No	92	96.8%
	Yes	3	3.2%
Urological complication	No	90	94.7%
	Yes	5	5.3%
Mortality	No	92	96.8%
	Yes	3	3.2%
Cause of death	No	92	96.8%
	Sepsis	3	3.2%

Table 3: Association of immediate graft function with graft survival and impact of renal artery type on clinical outcomes

		IMGF		**P value**
		No	**Yes**	
Graft survival 3, 6 months	No	1 (9.1%)	0	0.005
	Yes	10 (90.9%)	84 (100%)	
		Number of renal arteries		P value
		Single artery	Multiple arteries	
Vascular complication	No	79 (98.8%)	13 (86.7%)	0.014
	Yes	1 (1.3%)	2 (13.3%)	
Urological complication	No	76 (95%)	14 (93.3%)	0.791
	Yes	4 (5%)	1 (6.7%)	
Mortality	No	80 (100%)	12 (80%)	<0.0001
	Yes	0	3 (20%)	

DISCUSSION

The findings from our institutional experience comparing allografts with single renal arteries (SRA) and multiple renal arteries (MRA) provide critical insights into the outcomes of renal transplantation. Most patients in this cohort underwent transplantation with SRA allografts, reflecting the preferred anatomical configuration for transplantation. Patients with SRA demonstrated significantly better outcomes in terms of lower vascular complications and zero mortality, emphasizing the relative technical ease and reduced risk associated with these grafts. Conversely, MRA allografts were associated with higher vascular complications (13.3%) and a mortality rate of 20% due to sepsis. These findings align with the existing literature, which underlines the challenges of managing MRA allografts, including prolonged surgical time, increased anastomotic complexity, and elevated postoperative risk. Kidneys treated with MRAs are linked to increased rates of vascular complications, delayed graft function, and extended warm ischemia time.[7]

Husain et al. reported that multi-artery kidneys experienced longer cold ischemia times; however, the rates of delayed graft function were comparable (50% vs. 45%, p=0.07). While deceased donor kidneys with MRA are more difficult to transplant than those with an SRA, they show similar rates of delayed graft function and early graft failure.[8] Ghazanfar et al noted that living donor transplants with MRA showed 1- and 5-year graft survival of 93% and 87%, respectively.[9] However, Sevmis et al. reported that MRA grafts do not increase the risk of delayed graft function, vascular injury, or biopsy-proven acute tubular necrosis, suggesting comparable outcomes between MRA and SRA grafts during the first post-transplant year.[10]

Data on living-donor transplantation using MRA grafts show inconsistencies, which can be attributed to differences between institutions. Some studies indicate that the outcomes are similar, while others point to longer surgery times and varying graft survival rates based on the reconstruction methods used.[11,12] A meta-analysis involving 23 studies, each with more than 50 patients receiving MRA and comparable SRA data, revealed higher rates of postoperative complications and a greater risk of delayed graft function. However, there were no significant differences noted in long-term graft function or patient survival.[7]

Immediate graft function (IMGF) has emerged as a pivotal factor influencing graft survival at 3 and 6 months. Patients with IMGF had a 100% graft survival rate compared with 90.9% in those without IMGF. This highlights the importance of optimizing perioperative conditions to achieve IMGF, particularly in MRA allograft recipients. Scheuermann et al. reported that increasing the complexity of vascular structures significantly extended the warm ischemia time and also lengthened the duration of the operation. There were no significant differences in surgical complications, kidney function (including delayed graft function, non-function, and acute rejection), or long-term graft survival.[2]

Acute tubular necrosis (ATN) was observed in 10.5% of patients but did not significantly differ between the SRA and MRA groups, suggesting that ATN might be influenced more by donor and recipient factors than by the number of renal arteries. A large study on living donor transplants with MRA showed that vascular complications (8.9%) and acute tubular necrosis (5.5%) were more common, but overall outcomes were not adversely affected by the number of arteries.[9] Roth et al. stated that in living donor kidney transplantation, arterial vascular reconstructions for kidneys with MRA yield results that are similar to those of grafts with SRA. Both short- and long-term outcomes are comparable to standard procedures.[5]

Although urological complications occurred in both groups, the difference was not statistically significant. However, these complications coupled with the observed mortality in the MRA group highlight the need for rigorous perioperative monitoring and early intervention. Mortality in this study was exclusively related to sepsis, emphasizing the critical need for robust infection control practices in transplant recipients, especially those receiving MRA allografts. However, other institutional series report no significant differences in the rates of vascular and urologic complications, as well as graft survival, when comparing SRA and MRA kidneys in living donor kidney transplantation.[4,13] Afriansyah et al. observed that MRA allografts showed a higher risk of one-year graft loss (OR 1.57, 95% CI 1.09–2.26, p = 0.016) and increased recipient vascular and ureteral complications compared to SRA allografts.[14]

Additionally, Kasap et al. stated that warm ischemia and operation times were significantly higher in multiple artery donor nephrectomies (p < .001), but graft function, acute rejection, and mortality rates were comparable between groups. Transplants with multiple renal arteries showed acceptable outcomes and complications.[15] Moreover, Scheuermann et al., concluded that the presence of MRAs should not be a reason to exclude deceased donor kidney transplantation, as the associated morbidity and outcomes are similar to those of single-artery grafts.[2] MRAs can be safely used, regardless of the reconstruction technique, as long as the graft's arterial supply is maintained.[16]

Limitations

The limitations of this study include the relatively small sample size, particularly for the MRA group, which may limit the generalizability of the findings. The retrospective nature of the study may have introduced bias in data collection and interpretation. The lack of long-term follow-up precludes the assessment of chronic graft function and patient survival beyond six months. Future studies should focus on improving surgical techniques and strategies to mitigate the risks associated with multiple renal artery allografts. The development of standardized protocols for managing these complex cases could further enhance the outcomes.

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CONCLUSION

This study demonstrates that renal transplantation outcomes are superior to those of single renal artery allografts compared to those of multiple renal arteries. Immediate graft function plays a critical role in ensuring graft survival and multiple renal arteries are associated with higher vascular complications and mortality. These findings highlight the importance of surgical expertise, meticulous perioperative care, and targeted postoperative management of patients with anatomically complex allografts.

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