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Original Research Article

STUDY THE LONG-TERM OUTCOMES OF LIVE RENAL TRANSPLANTS FROM HEALTHY VERSUS COMPLEX LIVING DONORS: A COMPARATIVE STUDY

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Abstract

Background: Live renal transplantation remains the preferred treatment for end-stage renal disease, with healthy donors being the standard. However, complex living donors are increasingly utilised because of organ shortages, necessitating an evaluation of their outcomes compared with healthy donors. This study aimed to compare the outcomes of live renal transplantation in healthy and complex living donors. **Materials and Methods:** This retrospective study involved 36 live renal transplantations at the Government Kilpauk Medical College between February 2023 and May 2024, with follow-up until December 2024. Complex donors were identified based on advanced age, comorbidities, and vascular anomalies, and the outcomes assessed included renal function, graft survival, and mortality. **Result:** Among complex donors, 65% had a single risk factor and 35% had two or more risk factors, with incompatible transplants being the most common (40%). Delayed renal function normalisation occurred in 25% of complex donor recipients, and graft rejection requiring dialysis affected 40%, compared with none in healthy donor recipients. Long-term graft function was normal in 35% of complex donor recipients versus 75% of healthy donor recipients. Mortality was 10% in complex donors, primarily due to bacterial sepsis, compared with 18.8% in healthy donors, and there were no significant differences in death (p=0.200). **Conclusion:** Complex donors expand the pool, but show delayed graft recovery and higher rejection rates. Healthy donors have better long-term outcomes. Rigorous evaluations and future research are vital for optimized practices.

INTRODUCTION

Kidney transplantation serves as a fundamental component in the management of end-stage renal disease (ESRD), offering significant improvements in survival and quality of life compared to dialysis.[1] However, the demand for kidney transplants continues to exceed the supply of deceased donor organs, leading to an increasing reliance on living donors to bridge this gap.[2] Living donor kidney transplantation (LDKT) has Presented evidence of superior outcomes in terms of graft survival, making it a vital component of transplantation programs worldwide.[3]

In recent years, the utilization of living donors with complex medical histories such as those with controlled comorbidities, older age, or a history of prior surgeries has expanded significantly.[4] This shift is driven by the urgent need to increase the donor pool and the recognition that many individuals with such histories can still serve as safe and effective donors with appropriate evaluation and management.[5] However, the long-term outcomes associated with kidney transplants from these "complex" donors remain less well understood compared to outcomes from healthy donors.[6]

Evaluating the long-term results of kidney transplants from both healthy and complex donors is critical for ensuring optimal patient care and donor safety. Insights from such comparisons can inform clinical decision-making, refine donor selection criteria, and support evidence-based guidelines to optimize outcomes for both recipients and donors.[7] Addressing these knowledge gaps is particularly significant as the transplant community strives to balance the benefits of expanding the donor pool against potential risks to recipients and donors alike.

The question here is whether there are significant differences in long-term graft survival and patient outcomes between recipients of kidneys from healthy living donors and those from complex living donors. This question underscores the need for robust

comparative analyses to guide transplantation practice.

The rationale for this study stems from the increasing reliance on complex living donors due to the global organ shortage.[8] While these donors help address the critical need for kidneys, their unique characteristics may influence transplantation outcomes.[9]

This study aimed to evaluate and compare the outcomes of live renal transplantation using organs from healthy living donors versus complex living donors, focusing on recipient survival, graft function, and complication rates.

Review of Literature

Gopalakrishnan et al. (2007) reviewed marginal kidney donors, noting higher delayed graft function (84% vs. 26%) and primary non-function (16% vs. 10%) in NHBDs. Kidneys from ECDs (age >60 years) had higher risks of late graft loss. Complex living donors with mild comorbidities showed slightly reduced outcomes, but good allograft function. Despite challenges, marginal donors significantly improve survival over dialysis, emphasizing rigorous evaluation and long-term follow-up for optimized outcomes.[10]

Umberto et al. (2014) reviewed strategies for marginal kidney donors, noting comparable outcomes for controlled donation after circulatory death versus brain death, despite higher delayed graft function (DGF). Dual kidney transplantation increased the number of transplants by 12% in kidneys with high KDPI. While pre-transplant biopsies remain key, emerging perfusion technologies reduce DGF but do not improve long-term outcomes, emphasizing careful evaluation to balance donor pool expansion and recipient safety.[11]

Niemi et al. (2014) reviewed the outcomes of kidney donation from medically complex donors, noting the increased inclusion of individuals with conditions such as obesity, hypertension, or older age. They reported post-donation renal function stabilization at 70% of pre-donation levels and an ESRD incidence of 180 per million person-years for donors, lower than that in the general population (268 per million). Recipient outcomes showed comparable survival and graft longevity, with medically complex donor kidneys providing significant survival benefits over dialysis, emphasizing the need for rigorous evaluation and tailored monitoring.[12]

Thukral et al. (2018) in their retrospective study assessed 69 complex kidney donors, defined by advanced age or comorbidities, such as hypertension or obesity. At a 5-year follow-up, donors showed significant declines in estimated glomerular filtration rate (eGFR) from 81.19 mL/min to 58.77 mL/min ($p < 0.001$), increased hypertension (73.9% post-donation), and new-onset diabetes (22.3%). Despite these risks, the majority maintained adequate renal function and no donor mortality was directly attributed to the donation.[13]

Garcia et al. (2021) conducted a retrospective study comparing the clinical outcomes between single- and multiple-artery living-donor kidney transplantations in 210 patients. The results indicated no significant differences in postoperative complications, urologic complications, hospital stay, delayed graft function, or graft survival between SA and MA transplants. The mean eGFR at 12 months post-transplant was comparable (SA: 76.7 mL/min/1.73m² vs. MA: 71.6 mL/min/1.73m²). The study emphasized the feasibility and safety of vascular reconstruction for MA grafts without compromising outcomes.[14]

Aim

To study and compare the outcomes of live renal transplantations from healthy and complex living donors.

MATERIALS AND METHODS

This retrospective observational study included 36 patients who underwent live renal transplantation over a 1-year and 3-month period in the Renal Transplant ICU, at Government Kilpauk Medical College and Hospital, Chennai, between February 2023 and May 2024, with follow-up until December 2024. This study was approved by the Institutional Ethics Committee before initiation, and informed consent was obtained from all patients.

Inclusion criteria

Patients who underwent live renal transplantation during the study period were included in the study.

Exclusion criteria

Patients who had undergone cadaveric renal transplantation were excluded.

Methods

Complex living donors were defined as those meeting at least one of the following criteria: age ≥ 60 years, hypertension controlled by a single antihypertensive drug (BP ≥ 140/90 mmHg), impaired glucose tolerance (FBS 100-125 mg/dL, PPBS 140-199 mg/dL, HbA1C 5.7-6.4%) or diabetes on oral hypoglycaemic agents, nephrolithiasis (single stone ≤ 1.5 cm), renal vascular anomalies or atherosclerotic renal vasculature, ABO incompatibility, anti-HBc-positive serology, or known cardiovascular or respiratory disease under treatment. Consecutive sampling was employed, and the participants were followed up to assess the graft function and patient outcomes.

Statistical analysis: Data are presented as frequency and percentage. Categorical variables were compared using Pearson's chi-square test. Significance was defined as $p < 0.05$ using a two-tailed test. Data analysis was performed using IBM-SPSS version 21.0 (IBM-SPSS Corp., Armonk, NY, USA).

RESULTS

The analysis of complex living donors revealed that the age distribution was primarily concentrated in the 41-50 and 51-60 age groups, each accounting for 30% of donors, while 25% were over 60 years old and 15% were between 31-40 years. Gender analysis showed a predominance of female donors,

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constituting 75%, compared to 25% of males. Most complex donors 65% had a single risk factor, whereas 35% had two or more risk factors contributing to their classification.

The most common was incompatible transplant, observed in 40% of cases, followed by vascular anomalies in 30%, and advanced age in 25%. Hypertension and diabetes mellitus were present in 15% of the cases, while respiratory problems, anti-HBc positivity, and cardiac problems accounted for 10% each.

Normalisation occurred within the first three postoperative days in 33% of patients, between the fourth and sixth days in 30%, and between the seventh and tenth days in 10%. Delayed normalization was observed in 25 patients.

Long-term outcomes showed that 35% of the patients maintained normal graft function, while chronic graft dysfunction was observed in 10% of the cases. Graft rejection requiring dialysis occurred in 40% of patients, and graft nephrectomy was performed in 8% of patients. Mortality was documented in 10% of the patients.

The primary causes of graft rejection included recurrent sepsis in 30% of the cases, vascular complications in 20%, and chronic rejection in 10%. Drug-induced nephrotoxicity was noted as the cause in 5% of the rejection cases [Table 1].

Table 1: Comprehensive analysis of complex donors.

Parameter	Categories	No. of Complex Donors N (%)
Age (years)	31-40	3 (15%)
	41-50	6 (30%)
	51-60	6 (30%)
	> 60	5 (25%)
Gender	Males	5 (25%)
	Females	15 (75%)
Number of risk factors	1	13 (65%)
	≥ 2	7 (35%)
Risk factors	Incompatible transplant	8 (40%)
	Vascular anomalies	6 (30%)
	Advanced age	5 (25%)
	Diabetes mellitus	3 (15%)
	Hypertension	3 (15%)
	Respiratory problems	2 (10%)
	Anti-HBc+	2 (10%)
	Cardiac problems	2 (10%)
RFTs normal on postoperative day	0-3rd	8 (40%)
	4th-6th	6 (30%)
	7th-10th	5 (25%)
	Delayed	1 (5%)
Long term outcomes	Normal graft function	7 (35%)
	Chronic graft dysfunction	2 (10%)
	Graft rejection on dialysis	8 (40%)
	Graft nephrectomy	1 (5%)
	Death	2 (10%)
Causes of rejection	Recurrent sepsis	6 (30%)
	Vascular complications	2 (10%)
	Chronic rejection	2 (10%)
	Drug-induced nephrotoxicity	1 (5%)

The results of healthy donors revealed that the age distribution was dominated by the 41-50 age group, accounting for 43.8% of donors, followed by 31.3% in the 51-60 age group. The younger age groups (< 30 and 31-40) contributed 6.3%, and 12.5% were above 60 years. The gender distribution showed a higher proportion of female donors (68.8%) than males (31.3%).

Renal function tests (RFTs) were normalised within the first three postoperative days in 43.8% of patients, while normalisation occurred between the fourth and sixth days in 18.8% of cases. Similarly, 18.8% normalised between the seventh and thirteenth days, while 12.5% experienced delayed normalisation.

Regarding long-term outcomes, 75% of patients achieved normal graft function. Chronic graft dysfunction was noted in 6.3% of cases, while mortality was observed in 18.8% of patients [Table 2].

Table 2: Comprehensive analysis of healthy donors

Parameter	Categories	No. of Healthy donors N (%)
Age (years)	< 30	1 (6.3%)
	31-40	1 (6.3%)
	41-50	7 (43.8%)
	51-60	5 (31.3%)
	> 60	2 (12.5%)
Gender	Males	5 (31.3%)
	Females	11 (68.8%)

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RFTs Normal on Postoperative Day	0-3rd	7 (43.8%)
	4th-6th	3 (18.8%)
	7th-13th	3 (18.8%)
	Delayed	2 (12.5%)
Long Term Outcomes	Normal graft function	12 (75%)
	Chronic graft Dysfunction	1 (6.3%)
	Death	3 (18.8%)

Among recipients of healthy donor kidneys, death was attributed to cardiovascular events in 66.7% of cases and other unspecified causes in 33.3%. Recipients of complex donor kidneys experienced death exclusively due to bacterial or fungal sepsis, accounting for 100% of the fatalities. There were no significant differences in the causes of death between the two groups (p=0.200) [Table 3].

Table 3: Comparison of causes of death among recipients of healthy and complex donor kidneys

Deaths	Recipients- healthy donors N (%)	Recipients- complex donors N (%)	P value
Bacterial/fungal sepsis	0	2 (100%)	0.200
Cardiovascular events	2 (66.7%)	0	
Other	1 (33.3%)	0	

DISCUSSION

Our study evaluated and compared the outcomes of live renal transplantation from healthy and complex living donors, providing insights into the clinical implications of donor complexity. The outcomes among recipients of complex living-donor kidneys remain acceptable; they involve a higher prevalence of complications, such as delayed renal function recovery and increased rejection rates, compared to recipients from healthy donors.

In our study, complex living donors had a higher prevalence of advanced age (≥ 60 years, 25%) and comorbidities including hypertension, diabetes mellitus, and vascular anomalies, with 35% exhibiting two or more risk factors. Renal function tests normalised within the first three postoperative days in 33% of recipients of complex donor kidneys, with a delayed normalisation rate of 25%. Recipients from healthy donors had a higher rate of early RFT normalisation (43.8% within the first three days) and lower rates of delayed recovery (12.5%). Long-term graft function remained normal in 35% of recipients from complex donors, whereas 40% experienced graft rejection requiring dialysis. Among the recipients of healthy donors, 75% retained normal graft function and only 6.3% showed chronic graft dysfunction. Mortality was 10% among recipients of complex donors compared to 18.8% among recipients of healthy donors, with bacterial or fungal sepsis contributing exclusively to deaths in the latter group.

A major strength of our study is the comprehensive evaluation of complex living donors in a real-world, single-centre setting, which offers valuable insights into the nuances of graft survival and patient outcomes. This retrospective observational design allowed for the identification of detailed donor profiles and post-transplant outcomes. However, limitations include the relatively small sample size (n=36) and single-centre nature, which may limit the generalisability of the findings. Our study focused on early and long-term outcomes, larger multicentre trials are needed to validate our findings and further explore the underlying mechanisms.

Our findings align with Niemi and Mandelbrot (2014), who reported that recipients of kidneys from medically complex donors had a slightly lower 5-year graft survival rate of 90% compared to healthy donors of 95%, with increased risks of hypertension and proteinuria among donors.12 Similarly, Lim et al. (2013) observed that older donor kidneys (> 60 years) had reduced eGFR (45 mL/min) compared to younger donor kidneys (56 mL/min) at five years, which parallels our observation of lower functional outcomes in complex donors.15 Garcia et al. (2021) demonstrated that vascular anomalies, a common risk factor in complex donors, did not significantly impact graft survival, underscoring the viability of complex donors when managed surgically.[14]

Thukral et al. (2018) study found a significant decline in post-donation eGFR in donors with multiple comorbidities, alongside increased rates of delayed graft function, findings consistent with our study.[13] Gopalakrishnan and Gourabathini (2007) supported the use of marginal donors, reporting 5-year graft survival rates of 80% compared to 85% in healthy donors, mirroring the marginally lower outcomes observed in our cohort.[10]

The controversy lies in the long-term safety and ethical considerations of utilizing complex living donors, as underscored by Reese et al. (2015), who emphasized the potential for increased donor morbidity, such as ESRD and hypertension, even in well-selected donors.[16] Our findings add to this debate by demonstrating acceptable short-term outcomes but highlight the need for stringent donor evaluations to minimize risks.

Future research should focus on large-scale, multicentre trials to validate these findings and assess the cost-effectiveness of utilizing complex donors in the context of organ shortage. Prospective studies evaluating the role of innovative surgical and immunological interventions in improving the outcomes of complex donor transplants are also valuable. Overall, our study provides a critical contribution to the evidence base, supporting the

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judicious use of complex living donors to address the growing demand for renal transplants.

CONCLUSION

This study highlighted that live renal transplantation from both healthy and complex living donors is a viable option, with healthy donors showing superior graft function and fewer complications. Complex donors contribute to the expansion of the donor pool, although recipients exhibit higher rates of delayed graft function and rejection. The causes of mortality varied between groups, with bacterial sepsis prominent in complex donor recipients. Donor selection and individualised recipient care are critical factors. Future studies should explore strategies to optimise outcomes and evaluate long-term implications for both donor types.

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