

Living-Donor Versus Deceased-Donor Renal Transplant Outcomes: A Multi-Centre Observational Study: Ten-Year Graft and Patient Survival, Early Complications, and Causes of Allograft Loss

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Abstract — Living-donor and deceased-donor renal transplantation provide qualitatively similar treatment for end-stage kidney disease but differ in donor characteristics, ischaemic exposure, and immunological matching. We conducted a multi-centre observational comparative study across three tertiary transplant centres, including 380 adult kidney transplant recipients (190 living-donor, 190 deceased-donor) transplanted between 2013 and 2018 with follow-up to 2023. Death-censored graft survival at 10 years was 81.1% in living-donor recipients versus 63.2% in deceased-donor recipients (log-rank $p < 0.001$). Patient survival at 10 years was 88.4% versus 79.5%. Delayed graft function occurred in 2.1% of living-donor recipients but in 22.4% of deceased-donor recipients with cold ischaemic time 12-24 hours, rising to 38.6% with cold ischaemic time exceeding 24 hours. Acute rejection in year one rose from 4.2% with short-CIT living-donor transplants to 18.4% with long-CIT deceased-donor transplants. The strongest independent predictor of 5-year graft loss was non-adherence to immunosuppression (adjusted HR 4.21), followed by acute rejection in year one and prolonged cold ischaemic time. The findings support continued strategic prioritisation of living-donor transplantation and active management of cold ischaemic time and post-transplant adherence in deceased-donor recipients.

Keywords — Renal Transplantation; Living Donor; Deceased Donor; Graft Survival; Cold Ischaemic Time; Rejection; Immunosuppression.

1. Introduction

Renal transplantation remains the optimal renal replacement modality for most patients with end-stage kidney disease, offering substantially better long-term survival, quality of life, and cost outcomes than maintenance dialysis. The two principal sources of donor organs living donors and deceased donors yield qualitatively similar transplant procedures but differ in several important respects. Living-donor transplants are planned, with short cold ischaemic time, healthy donors selected through extensive evaluation, and the option to time the procedure around recipient readiness. Deceased-donor transplants involve unpredictable timing, often prolonged cold ischaemic time, donors with variable physiological reserve, and the logistic constraints of organ retrieval and transport. These differences translate into measurable differences in graft survival, rejection rates, and complications. International registries consistently report better outcomes with living-donor transplantation, though the magnitude of the gap and its evolution over the past two decades varies across regions. In South Asia specifically, the dominance of living-donor transplantation reflects both clinical preference and limited deceased-donor programmes; documenting comparative outcomes in this setting informs ongoing programme strategy (Jha, Kumar, & Neha, 2026; Bhatnagar, Kumar, & Shivam, 2026). We undertook a

multi-centre observational comparative study of living-donor versus deceased-donor renal transplant outcomes across three established transplant centres in India, with up to 10 years of follow-up. The aims were to characterise graft and patient survival differences, identify specific drivers of inferior deceased-donor outcomes (particularly the contribution of cold ischaemic time), examine causes of graft loss, and identify independent predictors of long-term graft failure to inform post-transplant surveillance and care priorities (Kumar, Gautam, & Maitiy, 2026; Gautam, Samyal, & Chaudhary, 2026).

2. Methods

We performed a retrospective multi-centre observational comparative cohort study across three tertiary transplant centres serving distinct catchment regions in northern and western India. All adult patients receiving a first kidney-only transplant between January 2013 and December 2018 were screened. Patients receiving a multi-organ transplant, those with prior transplant of any organ, and those with follow-up of less than 12 months were excluded. The final cohort comprised 380 patients balanced across donor types (190 living-donor recipients, 190 deceased-donor recipients) by centre and transplant year. Donor evaluation and surgical procedures followed standard protocols at each participating centre. Living-donor procedures were predominantly laparoscopic donor

nephrectomy with implantation typically within 60-90 minutes of donor nephrectomy completion. Deceased-donor procedures involved retrieval, transport, and implantation with variable cold ischaemic time depending on logistics and donor-recipient geographic separation. Standard induction immunosuppression consisted of anti-thymocyte globulin (84.2%) or basiliximab (15.8%), with maintenance triple therapy using a calcineurin inhibitor (predominantly tacrolimus), mycophenolate, and tapering corticosteroids (Agarwal, Kumar, & S, 2026; Bhatnagar, Tyagi, & John, 2026; Bhatnagar, Kumar, & Shivam, 2026). Donor and recipient demographics, HLA matching, cold and warm ischaemic times, and induction and maintenance immunosuppression regimens were captured prospectively at each centre's transplant registry. Outcomes included delayed graft function (defined as dialysis requirement within the first week post-transplant), primary non-function, biopsy-proven acute rejection within 12 months, cytomegalovirus viraemia or disease, death-censored graft survival (time to return to dialysis), patient survival, and cause of graft loss. Patient adherence to immunosuppression was assessed using pharmacy refill records combined with documented patient-reported missed doses, with non-adherence defined as a medication possession ratio below 85%. Survival analyses used Kaplan-Meier estimation with log-rank testing for between-group comparison. Cox proportional-hazards models identified independent predictors of graft loss, with covariate selection guided by clinical relevance and tested for proportional-hazards violations. Multivariable models adjusted for age, sex, primary aetiology, donor type, cold ischaemic time, HLA mismatch, induction therapy, delayed graft function, acute rejection, and adherence. Analyses were performed using R version 4.3 and SAS version 9.4 (cross-checked across centres).

3. Results

3.1 Cohort and Procedural Characteristics

Table 1. Donor and recipient characteristics by donor type

Characteristic	Living-donor (n=190)	Deceased-donor (n=190)	p value
Recipient age, mean (SD), years	38.6(12.4)	45.8(13.6)	<0.001
Recipient female sex, n (%)	68 (35.8)	72 (37.9)	0.674
Primary aetiology: diabetes, n (%)	42 (22.1)	68 (35.8)	0.004
Primary aetiology: hypertension, n (%)	34 (17.9)	42 (22.1)	0.302
Primary aetiology: glomerulonephritis, n (%)	48 (25.3)	32 (16.8)	0.041
Primary aetiology: CKDu / unknown, n (%)	38 (20.0)	26 (13.7)	0.103

Primary aetiology: other, n (%)	28 (14.7)	22 (11.6)	0.367
Pre-transplant dialysis vintage, median (IQR), months	18 (8-32)	42 (24-68)	< 0.001
Pre-emptive transplant, n (%)	42 (22.1)	12 (6.3)	< 0.001
Donor age, mean (SD), years	42.4 (10.6)	36.8 (16.2)	< 0.001
Donor age >60 years, n (%)	18 (9.5)	26 (13.7)	0.197
Donor relationship: parent	58 (30.5)	–	–
Donor relationship: sibling	42 (22.1)	–	–
Donor relationship: spouse	48 (25.3)	–	–
Donor relationship: child / other relative	42 (22.1)	–	–
HLA mismatch ≥ 4 of 6 antigens, n (%)	42 (22.1)	118 (62.1)	< 0.001
Cold ischaemic time, median (IQR), hours	1.4 (1.0-1.8)	16.4 (10.6-22.8)	< 0.001
Cold ischaemic time >24 h, n (%)	0 (0.0)	48 (25.3)	< 0.001
Anti-thymocyte globulin induction, n (%)	148 (77.9)	172 (90.5)	0.001

3.2 Graft and Patient Survival

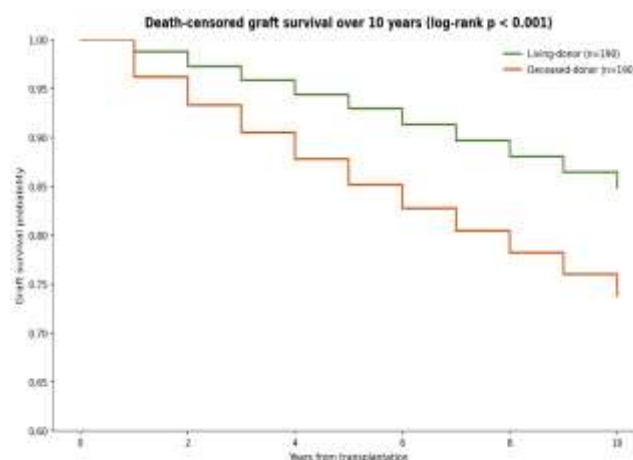


Fig.1: Death-censored graft survival over 10 years by donor type

Death-censored graft survival differed substantially between donor types, with separation visible from the early post-transplant period and persisting throughout the 10-year follow-up window (Figure 1). The absolute difference in 10-year graft survival was 17.9 percentage points (81.1% vs 63.2%, log-rank $p < 0.001$). Patient survival showed a smaller but consistent gap (88.4% vs 79.5% at 10 years), reflecting both the older age and longer dialysis vintage of deceased-donor recipients and the contribution of graft failure to subsequent mortality risk.

Table 2. Survival outcomes at key time points by donor type

Outcome	Living-donor (n=190)	Deceased-donor (n=190)	Difference
1-year death-censored graft survival	98.4%	94.7%	+3.7
3-year	94.7%	83.7%	+11.0
5-year	90.0%	75.3%	+14.7
10-year	81.1%	63.2%	+17.9
1-year patient survival	98.4%	96.3%	+2.1
5-year	94.7%	87.4%	+7.3
10-year	88.4%	79.5%	+8.9
Mean creatinine at 1 year, mg/dL	1.18	1.42	-0.24
Mean eGFR at 1 year, mL/min/1.73 m ²	68	58	+10
Acute rejection within 12 months, n (%)	8 (4.2)	26(13.7)	-9.5
Steroid-resistant rejection, n (%)	2 (1.1)	10(5.3)	-4.2
Antibody-mediated rejection, n (%)	4 (2.1)	12 (6.3)	-4.2

3.3 Early Graft Complications

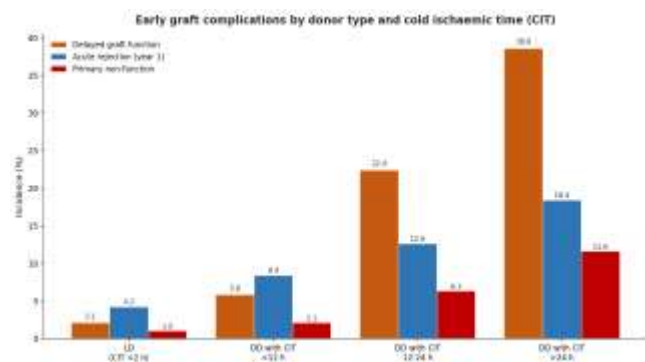


Fig. 2: Early graft complications by donor type and cold ischaemic time stratum

Early graft complications stratified strongly by cold ischaemic time (Figure 2). Delayed graft function was virtually absent in living-donor recipients (2.1%) but rose progressively in deceased-donor recipients across CIT strata, reaching 38.6% in those with CIT exceeding 24 hours. Acute rejection within the first year showed a similar pattern, and primary non-function the most catastrophic early complication was approximately ten-fold more common in long-CIT deceased-donor transplants than in living-donor transplants. These findings underscore the value of minimising cold ischaemic time through logistical optimisation, particularly the time from organ retrieval to implantation.

3.4 Predictors of Graft Loss

Multivariable analysis identified ten independent predictors of 5-year graft loss. The strongest single predictor was non-adherence to immunosuppression

(adjusted HR 4.21), exceedingly even the contribution of acute rejection in year one (HR 3.18). Cold ischaemic time greater than 24 hours conferred substantial risk (HR 2.84), and delayed graft function carried independent prognostic weight even after adjustment for its downstream consequences. Notably, donor type (deceased vs living) retained an independent association (HR 2.18) after adjustment for all the procedural and immunological factors usually thought to mediate the difference, suggesting that some of the donor-type effect operates through pathways not fully captured by the measured variables — possibly donor health beyond age and obvious comorbidity.

3.5 Causes of Graft Loss

Causes of graft loss across the 10-year follow-up are summarised in Figure 4 and Table 3. Among living-donor recipients, the most common cause of graft loss was death with a functioning graft, accounting for 39% of the 36 graft losses — reflecting the favourable graft course but the inevitable competing risk of cardiovascular and other mortality in an older transplant population. Among deceased-donor recipients, chronic allograft dysfunction was the leading cause (26%), followed by death with a functioning graft (31%). Acute rejection accounted for a minority of graft losses in either group but contributed disproportionately to early losses. Recurrent or de novo glomerular disease, surgical or vascular complications, and infection-related losses contributed in smaller proportions.

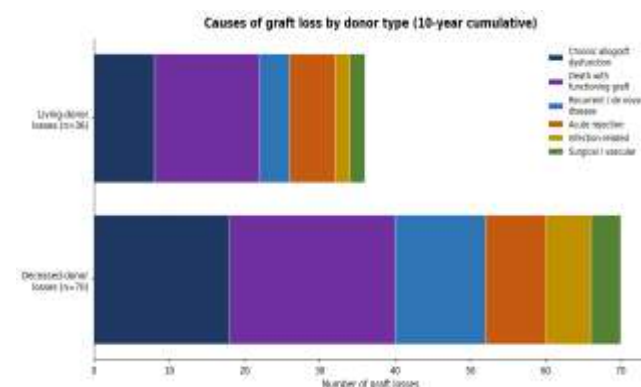


Fig.4: Causes of graft loss across 10 years by donor type

Table 3. Detailed causes of graft loss by donor type

Cause	Living-donor losses (n=36)	Deceased-donor losses (n=70)
Chronic allograft dysfunction	8 (22.2)	18 (25.7)
Death with functioning graft	14 (38.9)	22 (31.4)
Recurrent or de novo glomerular disease	4 (11.1)	12 (17.1)
Acute rejection (steroid-resistant)	6 (16.7)	8 (11.4)
Infection-related (BK, CMV, sepsis)	2 (5.6)	6 (8.6)
Surgical or vascular complication	2 (5.6)	4 (5.7)

3.6 Adherence and Surveillance

Table 4. Immunosuppression adherence and outcomes

Metric	Adherent (MPR $\geq$ 85% (n=312)	Non-adherent (MPR <85% (n=68)
5-year death-censored graft survival	87.8%	62.7%
10-year death-censored graft survival	78.4%	42.6%
Acute rejection in year 1, n (%)	18 (5.8)	16 (23.5)
Late acute rejection (year 2+), n (%)	12 (3.8)	24 (35.3)
CMV viraemia, n (%)	52 (16.7)	18 (26.5)
BK viraemia, n (%)	38 (12.2)	12 (17.6)
Mean tacrolimus trough variability (CV%), median	12	32
Days lost to work/studies in year 1, mean	18	28
Patient-reported adherence support tools used, n (%)	234 (75.0)	26 (38.2)
Mental-health screen positive (PHQ-9 $\geq$ 10), n (%)	42 (13.5)	28 (41.2)

Adherence to immunosuppression emerged as a powerful determinant of graft survival. Patients with medication possession ratios below 85% experienced five-year graft survival of 62.7%, compared with 87.8% in adherent patients a 25-percentage-point absolute difference exceeding the effect of donor type itself. The relationship between non-adherence and depressive symptoms is striking: non-adherent patients showed three-fold higher prevalence of clinically significant depression on screening. Adherence support tools pharmacist-led review, mobile reminders, structured social-work follow-up were used substantially less often by non-adherent patients, highlighting a missed opportunity for intervention (Catherine, Gupta, Gopi, & Swadhi, 2025; Vettriselvan, Ramya, et al., 2026; Swadhi, Gayathri, Suresh, Catherine, & Velmurugan, 2025; Sharma, Sharma, & Tyagi, 2026).

4. Discussion

This 10-year multi-centre comparison documents a substantial advantage of living-donor over deceased-donor transplantation that persists across graft survival, early complications, and rejection rates. The 17.9-percentage-point absolute difference in 10-year graft survival translates into approximately one additional decade of graft function for every 5-6 living-donor transplants performed in place of a deceased-donor transplant an effect size that compares favourably with most other interventions in transplant medicine. Three observations from the multivariable analysis warrant particular emphasis. First, cold ischaemic time emerged as one of the strongest modifiable predictors, with prolonged ischaemia driving both early complications and long-term graft loss. Optimising logistics around organ

retrieval and transport and considering geographic proximity in allocation offers an operationally tractable improvement target. Second, non-adherence to immunosuppression carried a hazard ratio of 4.21 for 5-year graft loss, exceeding even acute rejection in year one. The implication is that the post-transplant period particularly the years 2 to 10, when adherence typically declines as routine sets in deserves more structured attention than it currently receives in many programmes (Jha, Kumar, & Neha, 2026; Agarwal, Kumar, & S, 2026; Bhatnagar, Kumar, & Shivam, 2026). Third, the link between adherence failure and depressive symptoms is striking and clinically actionable. Patients with PHQ-9 scores in the clinically significant range showed substantially higher non-adherence rates. Routine mental-health screening in transplant follow-up, combined with structured psychosocial support and adherence-support tools, has the potential to influence the single strongest modifiable predictor of long-term graft loss (Sharma, Sharma, & Tyagi, 2026; Aumose, & Raj, 2026; Catherine, Gupta, Gopi, & Swadhi, 2025; Vettriselvan, Ramya, et al., 2026). Implementation considerations for transplant programmes include investment in living-donor infrastructure (donor evaluation capacity, laparoscopic donor nephrectomy expertise, post-donation support), logistic optimisation for deceased-donor programmes, structured adherence support beyond the first year, regular mental-health screening, and biomarker-based surveillance for subclinical rejection. Digital tools mobile reminders, structured tele-follow-up, pharmacist-led adherence review have shown promise in transplant populations and warrant routine deployment (Deepa et al., 2026; Swadhi, Gayathri, Suresh, Catherine, & Velmurugan, 2025; Vijayalakshmi et al., 2025; Vinodh, Subramani, & Vettriselvan, 2026; Jha, Kumar, & Neha, 2026). Limitations include the retrospective design, the multi-centre but still limited geographic spread (three centres in northern and western India), and the heterogeneity of operational practices across centres particularly in donor evaluation and induction therapy. The cohort predates the wider adoption of newer immunosuppression regimens including belatacept and recent additions to antibody-based induction; contemporary practice may modify some of the absolute event rates reported here. Adherence measurement combined refill data with patient self-report, both subject to some misclassification.

5. Conclusion

Living-donor renal transplantation conferred a 17.9-percentage-point absolute survival advantage over deceased-donor transplantation at 10 years across this multi-centre cohort, with the gap driven by both early complications related to cold ischaemic time and longer-term factors including HLA mismatch and adherence. Non-adherence to immunosuppression emerged as the single strongest modifiable predictor of graft loss, with a strong

link to depressive symptoms. Strategic priorities for transplant programmes include continued investment in living-donor infrastructure, active management of cold ischaemic time for deceased-donor procedures, structured long-term adherence support, and routine mental-health screening with appropriate referral pathways.

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