Research Square

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Kidney Transplantation in Autosomal Dominant Polycystic Kidney Disease: Long- Term Imaging and Clinical Outcomes

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Abstract

Background: Autosomal Dominant Polycystic Kidney Disease (ADPKD) is a leading cause of end-stage renal disease. Kidney transplantation restores renal function, but recipients remain at risk for cyst persistence, metabolic and cardiovascular (CV) complications, and malignancy. We evaluated long-term cyst behavior, complications, and survival in a Latin American cohort of ADPKD recipients.

Methods: We retrospectively analyzed 72 adults transplanted between 1985 and 2024 at a tertiary referral center. Height-adjusted total kidney volume (Ht-TKV) was quantified on CT at ~1 year post-transplant by an experienced radiologist. Secondary outcomes included liver cyst change, new-onset diabetes after transplantation (NODAT), metabolic and CV complications, infections, neoplasms, and patient/graft survival. Multivariable logistic regression adjusted for age, sex, donor type, dialysis duration, and immunosuppression.

Results: Median Ht-TKV decreased by 61% at 1 year (n=45). NODAT occurred in 23.8%, other metabolic complications in 38.9%, CV events in 20.8%, and infections in 65.3%. Neoplasms developed in 31.9% of patients, most frequently non-melanoma skin cancers. Median graft survival was 124.6 months; overall mortality was 18.1%. In multivariable models, male sex (OR 27.5, 95% CI 1.9–403.5) and shorter dialysis duration (OR 0.93 per month, 95% CI 0.88–0.99) predicted NODAT, whereas male sex (OR 10.2, 95% CI 1.5–70.6) and longer dialysis duration (OR 1.03 per month, 95% CI 1.00–1.05) were associated with CV events.

Conclusions: Kidney transplantation in ADPKD results in substantial regression of native kidney cysts and excellent long-term survival. Nonetheless, metabolic, CV, infectious, and oncologic complications remain highly prevalent. This large Latin American cohort with extended imaging and clinical follow-up underscores the need for systematic monitoring and sex-specific risk stratification.

Highlights

- This study reports one of the most comprehensive Latin American cohorts of ADPKD kidney transplant recipients, with >30 years of follow-up and systematic imaging.
- Native kidney cyst burden regressed substantially after transplantation, with a 61% median reduction in Ht-TKV at 1 year.
- Liver cyst behavior showed sex-related differences, with men more frequently exhibiting growth, underscoring the need for tailored monitoring.
- Despite favorable graft and patient survival, long-term complications were common: NODAT (~25%), other metabolic (~40%), cardiovascular (~20%), infectious (~65%), and oncologic (~32%, mostly skin cancers).
- Male sex and dialysis exposure independently predicted adverse cardiometabolic outcomes.
- Findings reinforce the need for long-term, individualized, and multidisciplinary surveillance in ADPKD recipients.

1. Introduction

Autosomal Dominant Polycystic Kidney Disease (ADPKD) is the most common hereditary kidney disorder and a leading cause of ESRD, affecting approximately 1 in 1000 to 1 in 2500 individuals worldwide. It is characterized by the formation of cysts in the kidney and other organs, along with connective tissue abnormalities. Mutations in PKD1 cause larger renal volumes and earlier end-stage renal disease (ESRD) onset compared to PKD2 mutations [1–3].

Patients with ADPKD often progress to ESRD in over 70% of cases, with total kidney volume being the best predictor for the rate of decline in kidney function [1–3]. During the last years, the prevalence of ADPKD patients undergoing renal transplantation has increased as a standard treatment [4,5].

However, post-transplant outcomes in ADPKD patients differ from those in non-ADPKD transplant recipients, owing to systemic manifestations such as liver cysts, cardiovascular complications, and metabolic risks, including new-onset diabetes mellitus after transplantation (NODAT) [6–8]. While kidney transplantation offers significant benefits in terms of renal function, it also presents unique challenges, such as managing persistent cyst growth, particularly in the liver, and increased cardiovascular morbidity. Recent studies suggest that personalized immunosuppressive strategies and close monitoring of metabolic and cardiovascular health could improve long-term outcomes in ADPKD patients [6,7].

Most published evidence comes from European and North American cohorts [6,7]. Reports from Hispanic and Latin American populations remain scarce, despite regional differences in genetics, comorbidities, and healthcare systems that may influence outcomes. In fact, evidence from the United States Renal Data System (USRDS) highlights racial and ethnic disparities in access to transplantation among Hispanic patients with ADPKD [9], underscoring the importance of regional data to complement the global literature. Moreover, although PKD1 vs PKD2 genotype has emerged as a prognostic determinant of disease severity, genetic testing is not universally available in many low- and middle-income countries, including Latin America, limiting stratification in routine care [1–3].

This study aimed to characterize long-term post-transplant outcomes in a cohort of Mexican ADPKD patients, focusing on cyst behavior, cardiovascular and metabolic complications, and the potential benefits of individualized immunosuppressive strategies

2. Materials and Methods

2.1 Study Design and Population

We conducted a retrospective cohort study including all adult patients with a confirmed diagnosis of autosomal dominant polycystic kidney disease (ADPKD) who underwent kidney transplantation at the National Institute of Medical Sciences and Nutrition “Salvador Zubirán” (Mexico City) between 1985 and

2024. ADPKD was diagnosed according to standard clinical and radiologic criteria (Ravine/Pei criteria when available, or typical imaging features with family history).

Inclusion criteria were: (I) age ≥18 years at transplantation, (II) confirmed ADPKD diagnosis, and (III) at least 12 months of post-transplant follow-up. Exclusion criteria were: (I) incomplete or missing essential clinical or imaging data (e.g., transplant date, follow-up CT), (II) loss to follow-up before 12 months, and (III) transplantation for indications other than ADPKD. Genetic testing (PKD1 vs PKD2) was not available in this cohort.

2.2 Clinical and Imaging Assessment

Baseline demographics, comorbidities, dialysis history (modality and duration), donor characteristics, immunosuppressive regimen, and perioperative details were obtained from electronic medical records.

Native kidney size was assessed by contrast-enhanced abdominal computed tomography (CT) performed approximately 12 months post-transplant. An experienced radiologist performed all measurements on the institutional PACS system. Total kidney volume (TKV) was estimated using the ellipsoid formula ($\pi/6 \times$ length $\times$ width $\times$ depth) and normalized by patient height (Ht-TKV, mL/m). Pre- and post-transplant values were compared, and relative percentage change was calculated. When available, liver cyst volume was also measured on serial CT scans.

2.3 Outcomes

The primary outcome was the change in Ht-TKV from baseline to ~12 months after transplantation. Secondary outcomes included changes in liver cyst volume, the incidence of new-onset diabetes after transplantation (NODAT, defined by ADA criteria or requirement of hypoglycemic therapy), other metabolic complications (new or worsening obesity, dyslipidemia, hypertension, or metabolic syndrome), cardiovascular events (left ventricular hypertrophy confirmed on echocardiography, heart failure, stroke, or intracranial/aortic aneurysm), infectious complications (bacterial, viral, fungal, or mixed), malignancies (cutaneous and visceral), and long-term patient and graft survival.

2.4 Statistical Analysis

Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on distribution. Categorical variables were expressed as absolute numbers and percentages. Between-group comparisons were performed using Student's t-test or Mann–Whitney U test for continuous variables, and χ^2 or Fisher's exact test for categorical variables.

Changes in Ht-TKV were assessed using paired comparisons and expressed as absolute and relative change. Patient and graft survival were analyzed using Kaplan–Meier methods.

To identify independent predictors of NODAT and cardiovascular events, multivariable logistic regression models were constructed adjusting for age, sex, donor type (living vs deceased), dialysis duration, and immunosuppressive regimen (calcineurin inhibitor– vs mTOR-based). Odds ratios (ORs) with 95%

confidence intervals (CIs) were reported. Sensitivity analyses explored the effect of sex, donor type, and immunosuppression (including mTOR inhibitor use).

All statistical tests were two-sided, and $p < 0.05$ was considered significant. Analyses were performed with IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA).

Ethics approval was obtained from the institutional review board, and the requirement for informed consent was waived given the retrospective design.

3. Results

3.1 Baseline Characteristics

Seventy-two patients with ADPKD underwent kidney transplantation during the study period. The cohort was predominantly male (62.5%) with a mean age of 51.0 ± 12.7 years. The mean BMI at transplant was 25.5 ± 4.0 kg/m². Most patients had hypertension (80.5%), while 12.5% had pre-existing diabetes and 30.5% had dyslipidemia. A history of smoking was documented in 36.1%. The majority required dialysis prior to transplantation (90.3%), most commonly hemodialysis (52.7%), followed by peritoneal dialysis (20.8%) or both modalities (16.6%). The mean dialysis exposure was 32.6 ± 29.8 months, and 9.7% of patients received pre-emptive transplantation (Table 1).

Variable	Value
Age, years, mean ± SD	51.0 ± 12.7
Male sex, n (%)	45 (62.5)
BMI, kg/m², mean ± SD	25.5 ± 4.0
Hypertension, n (%)	58 (80.5)
Type 2 Diabetes Mellitus, n (%)	9 (12.5)
Dyslipidemia, n (%)	22 (30.5)
Smoking, n (%)	26 (36.1)
Dialysis modality, n (%)	
– None (preemptive)	7 (9.7)
– Hemodialysis	38 (52.7)
– Peritoneal dialysis	15 (20.8)
– Both	12 (16.6)
Dialysis duration, months, mean ± SD	32.6 ± 29.8

Table 1. Baseline demographic and clinical characteristics of ADPKD kidney transplant recipients. Values are presented as mean ± standard deviation (SD) or number (percentage). BMI data were missing for some patients

3.2 Surgical Aspects

Native nephrectomy was not performed in most cases (72.2%), but was conducted before (16.7%), concurrently with (5.6%), or after transplantation (5.6%) in selected patients. Deceased donor kidneys accounted for 56.9% of grafts, with living related and living unrelated donors contributing 30.6% and 12.5%, respectively. All procedures were performed via open surgery. The mean estimated blood loss was 442 ± 343 mL, and intraoperative complications occurred in 3 patients (4.2%), including vascular anastomotic dehiscence, inadvertent polar artery ligation, and hematoma. The mean hospital stay was 9.6 ± 6.1 days. Thymoglobulin (31.9%) and basiliximab (29.2%) were the most common induction agents, while 12.5% of patients received no induction (Table 2).

Variable	Value
Native nephrectomy, n (%)	None 52 (72.2); Before 12 (16.7); Simultaneous 4 (5.6); After 4 (5.6)
Donor type, n (%)	Deceased 41 (56.9); Living related 22 (30.6); Living unrelated 9 (12.5)
Surgical technique, n (%)	Open 72 (100)
Estimated blood loss, mean ± SD (mL)	442 ± 343
Intraoperative complications, n (%)	3 (4.2)
Length of hospital stay, mean ± SD (days)	9.6 ± 6.1
Induction therapy, n (%)	Thymoglobulin 23 (31.9); Basiliximab 21 (29.2); Daclizumab 11 (15.3); None 9 (12.5); Other 8 (11.1)

Table 2. Surgical characteristics of ADPKD kidney transplant recipients.Values are presented as mean ± standard deviation (SD) or number (percentage). Intraoperative complications included vascular anastomotic dehiscence (n = 1), inadvertent polar artery ligation (n = 1), and hematoma (n = 1).

3.3 Imaging Outcomes

Imaging data were available in 45 patients for native kidney volume and in 36 patients for liver cysts. At approximately 1 year post-transplant, median Ht-TKV decreased by 61% (IQR –73 to –41), corresponding to a mean reduction of 41% (SD 0.65). Liver cyst volume showed a modest median decrease of 12% (IQR –25 to +5). Cyst growth greater than 0% occurred in 57.1% of men compared with 13.3% of women; however, this difference did not reach statistical significance (p = 0.36), likely due to limited sample size (Figure 1).

3.4 Metabolic and cardiovascular complications

New-onset diabetes after transplantation (NODAT) was diagnosed in 18 patients (25.0%). When excluding the 9 patients with diabetes at baseline, the incidence was 23.8% (15/63 at risk; 95% CI 15.0–35.6). Additional metabolic complications occurred in 28 patients (38.9%), mainly dyslipidemia (n=22), with smaller numbers experiencing new or worsening hypertension (n=3) or metabolic syndrome/obesity (n=3).

Cardiovascular complications occurred in 15 patients (20.8%; 95% CI 13.1–31.6). LVH was the most frequent finding (n=11), followed by stroke (n=4), heart failure (n=1), and intracranial aneurysm (n=1). In sex-stratified analysis, cardiovascular events were observed in 15.6% of men and 29.6% of women (p = 0.23), while metabolic complications were similarly distributed (42.2% in men vs 33.3% in women, p = 0.62). None of these differences reached statistical significance (Table 3).

Variable	Value
Serum creatinine (mg/dL), mean ± SD	Discharge 2.18 ± 2.35; 1 yr 1.50 ± 1.12; 10 yr 2.12 ± 2.90
Graft survival, mean ± SD (months)	124.6 ± 75.3
NODAT, n (%)	18 (25.0)
Other metabolic complications, n (%)	28 (38.9) (Dyslipidemia 22; New-onset or worsening hypertension 3; Obesity/metabolic syndrome 3)
Cardiovascular complications, n (%)	15 (20.8) (LVH 11; Stroke 4; HF 1; Aneurysm 1)
Infectious complications, n (%)	47 (65.3) (Bacterial 27; Viral 13; Fungal 6; Parasitic 1)
Neoplasms, n (%)	23 (31.9) (most frequent: non-melanoma skin 11, gynecologic/HPV 4)
Rejection episodes, n (%)	22 (30.6)
Deaths, n (%)	13 (18.1) (Cardiovascular 3; Infectious 3; Malignancy 2; Other 5)

Table 3. Post-transplant outcomes and complications in ADPKD kidney transplant recipients. Values are presented as mean ± standard deviation (SD) or number (percentage). NODAT = new-onset diabetes after transplantation; LVH = left ventricular hypertrophy; HF = heart failure.

3.5 Infectious and oncologic outcomes

Infectious complications were common, affecting 65.3% of patients (95% CI 53.8–75.2; Table 3). Bacterial infections predominated (n=27), followed by viral (n=13), fungal (n=6), parasitic (n=1), and mixed infections (n=1). Neoplasms developed in 23 patients (31.9%), most frequently non-melanoma

skin cancers (n=11) and gynecologic/HPV-related malignancies (n=4). Less frequent events included two lymphomas and isolated cases of breast, thyroid, and renal cell carcinoma.

3.6 Patient and graft survival

Mean graft survival was 124.6 ± 75.3 months. Kaplan–Meier estimates demonstrated excellent outcomes, with 5-year graft and patient survival rates of 95.8% and 97.1%, respectively, and 10-year rates of 88.8% and 85.2% (Figure 2). At last follow-up, overall mortality was 18.1% (13/72), most commonly due to cardiovascular (n=3) or infectious causes (n=3). Malignancy accounted for 2 deaths, and 5 were attributed to other causes.

3.7 Predictors of NODAT and Cardiovascular Events

On univariate analysis, male sex, living donor transplantation, and shorter dialysis duration were significantly associated with NODAT. In the multivariable model, male sex (OR 27.5, 95% CI 1.9–403.5, p = 0.016) and shorter dialysis duration (OR 0.93 per month, 95% CI 0.88–0.99, p = 0.014) remained independent predictors, while donor type was no longer significant.

For cardiovascular outcomes, male sex and longer dialysis exposure were significant on univariate analysis. In the adjusted model, male sex (OR 10.2, 95% CI 1.5–70.6, p = 0.018) and dialysis duration (OR 1.03 per month, 95% CI 1.00–1.05, p = 0.045) independently predicted cardiovascular events. Age and donor type were not associated with either endpoint (Table 4).

Exploratory comparisons by transplant period (2015–2019 vs 2020–2025) showed no statistically significant differences in the incidence of metabolic, cardiovascular, neoplastic, or NODAT outcomes (Supplementary Table 1). These findings should be interpreted cautiously given the small sample size of the recent cohort.

Predictor	Univariate OR (95% CI), p	Multivariable OR (95% CI), p	Univariate OR (95% CI), p	Multivariable OR (95% CI), p
	NODAT		**Cardiovascular events**	
Age (per year)	1.0 (0.96–1.03), 0.92	1.0 (0.96–1.03), 0.85	1.0 (0.97–1.04), 0.81	1.0 (0.96–1.04), 0.78
Sex (male vs. female)	9.1 (1.1–73.3), 0.039	**27.5 (1.9–403.5), 0.016**	4.6 (1.2–17.5), 0.024	**10.2 (1.5–70.6), 0.018**
Dialysis duration (mo)	0.94 (0.91–0.98), 0.002	**0.93 (0.88–0.99), 0.014**	1.03 (1.00–1.06), 0.042	**1.03 (1.00–1.05), 0.045**
Living donor (yes vs. no)	7.7 (1.9–31.3), 0.004	3.9 (0.6–24.3), 0.14	0.7 (0.2–2.5), 0.61	0.6 (0.1–2.4), 0.49

Table 4. Univariate and Multivariable Logistic Regression for Predictors of NODAT and Cardiovascular Events.

OR = odds ratio; CI = confidence interval; mo = months; NODAT = new-onset diabetes after transplantation. Significant associations ($p<0.05$) are highlighted in bold.

4. Discussion

In this single-center cohort with more than three decades of follow-up, kidney transplantation in patients with ADPKD was associated with excellent graft and patient survival, substantial regression of native kidney volume, and a high prevalence of long-term cardiometabolic, infectious, and oncologic complications. These findings expand the evidence base in a Latin American population, which remains underrepresented in the ADPKD literature.

Native nephrectomy was performed in a minority of patients, usually for indications such as recurrent infection, hemorrhage, severe hypertension, or massive kidney size. This aligns with previous reports indicating that nephrectomy is best reserved for selected cases [10–13]. The marked reduction in native kidney volume after transplantation, with most shrinkage occurring within the first year, supports a conservative approach, since symptoms attributable to organomegaly often abate once graft function is restored [18–21].

Our imaging results confirm prior observations that native kidney cyst burden regresses after successful transplantation. Conversely, liver cyst behavior was more variable: although most patients demonstrated stabilization, growth occurred in a subset, more frequently among men in our series. This differs from earlier studies suggesting a female predominance [19,20], highlighting the importance of sex-specific analyses and the need for long-term hepatic monitoring in ADPKD recipients.

Metabolic complications were frequent, with NODAT diagnosed in nearly one-quarter of recipients after excluding those with baseline diabetes. This incidence is consistent with the wide international range of 10–45% [26]. Importantly, our findings mirror registry data and meta-analyses reporting that ADPKD recipients carry an elevated risk of NODAT compared with other etiologies [27–29]. In our adjusted models, male sex and shorter dialysis exposure independently predicted NODAT, while male sex and longer dialysis duration independently predicted cardiovascular events. These associations reinforce the need for early cardiometabolic surveillance in high-risk subgroups.

It is noteworthy that the odds ratios for male sex, particularly in relation to NODAT, were unusually high. This likely reflects the modest number of events and asymmetric case distribution, which can produce quasi-complete separation in logistic regression. The wide confidence intervals emphasize this imprecision, and these findings should be interpreted as hypothesis-generating until validated in larger multicenter cohorts.

Infectious complications were observed in two-thirds of patients, underscoring the importance of preventive strategies and vigilant long-term monitoring. Neoplasms developed in nearly one-third, with non-melanoma skin cancers predominating, in line with prior reports [15]. Although ADPKD itself does not confer an increased risk of solid tumors beyond that of the transplant population in general, the high rate of cutaneous malignancies underscores the need for systematic dermatologic surveillance.

The potential role of mTOR inhibitors in attenuating cyst growth remains controversial. Initial studies suggested a benefit, but subsequent randomized trials failed to show clinically meaningful effects [30,31]. In our cohort, exploratory analyses suggested possible differences in outcomes among patients receiving mTOR therapy, but the sample size was too limited for firm conclusions. These observations are consistent with recent evidence indicating that mTOR-based regimens do not significantly increase short-term risk of post-transplant diabetes mellitus [32].

The strengths of this study include the long follow-up, incorporation of serial imaging, and systematic assessment of metabolic, cardiovascular, infectious, and oncologic outcomes. The sample size is relatively large for a single-center ADPKD cohort and represents the most detailed report from Latin America to date. Limitations include the retrospective design, potential referral bias from a tertiary care center, and incomplete imaging follow-up in a subset of patients. Genotypic information (PKD1 vs PKD2) was not available, precluding genetic stratification. Finally, the wide confidence intervals in some regression models reflect limited event numbers and caution against overinterpretation of effect sizes.

Overall, our findings demonstrate that transplantation offers excellent survival and significant regression of native kidney cyst burden in ADPKD. However, the high prevalence of long-term metabolic, cardiovascular, infectious, and oncologic complications mandates structured post-transplant surveillance. Particular attention should be given to cardiometabolic screening in men and patients with prolonged dialysis exposure, dermatologic monitoring for skin cancer, and longitudinal imaging for liver cyst progression. Future studies should integrate genetic data and multicenter collaboration to refine prognostic models and optimize individualized care in this population.

5. Conclusion

Kidney transplantation in ADPKD provides durable renal replacement and is accompanied by regression of native kidney cyst burden. Despite excellent graft and patient survival, metabolic, cardiovascular, infectious, and oncologic complications remain highly prevalent. Male sex and dialysis exposure independently predicted adverse cardiometabolic outcomes, underscoring the need for individualized follow-up. Long-term surveillance, including metabolic, cardiovascular, and oncologic monitoring, is essential to reduce morbidity and optimize outcomes in this population.

Declarations

Author Contributions

H.E.L.B: Project conception and design, data collection, statistical analysis, manuscript drafting, and critical revision.
G.H.M.D: Data interpretation, supervision, and critical revision of the manuscript.
L.J.B.P: Data collection, literature review, and critical revision of the manuscript.
A.B.R: Data collection, data management, and manuscript editing.
J.A.G.A and A.H.P.S: Radiological data acquisition and analysis, interpretation of imaging findings
L.A.G.R: Data collection and interpretation of results.
L.A.M.V.: Clinical data acquisition, patient follow-up coordination, and manuscript editing.

F.T.R.C: Manuscript drafting, and final approval
G.T.G.M: Project supervision, manuscript drafting, and final approval.

All authors reviewed and approved the final manuscript and meet the authorship criteria established by the International Committee of Medical Journal Editors (ICMJE).

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Conflicts of Interest

The authors declare no conflicts of interest. There are no financial or personal relationships that could have inappropriately influenced the work reported in this paper.

Ethics Approval

This study was approved by the Institutional Review Board of the Instituto Nacional de Ciencias Médicas y Nutrición “Salvador Zubirán” (Approval Reference: URO-5821-25-26-1). Given the retrospective design and use of de-identified data, the need for informed consent was waived by the IRB.

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Figures

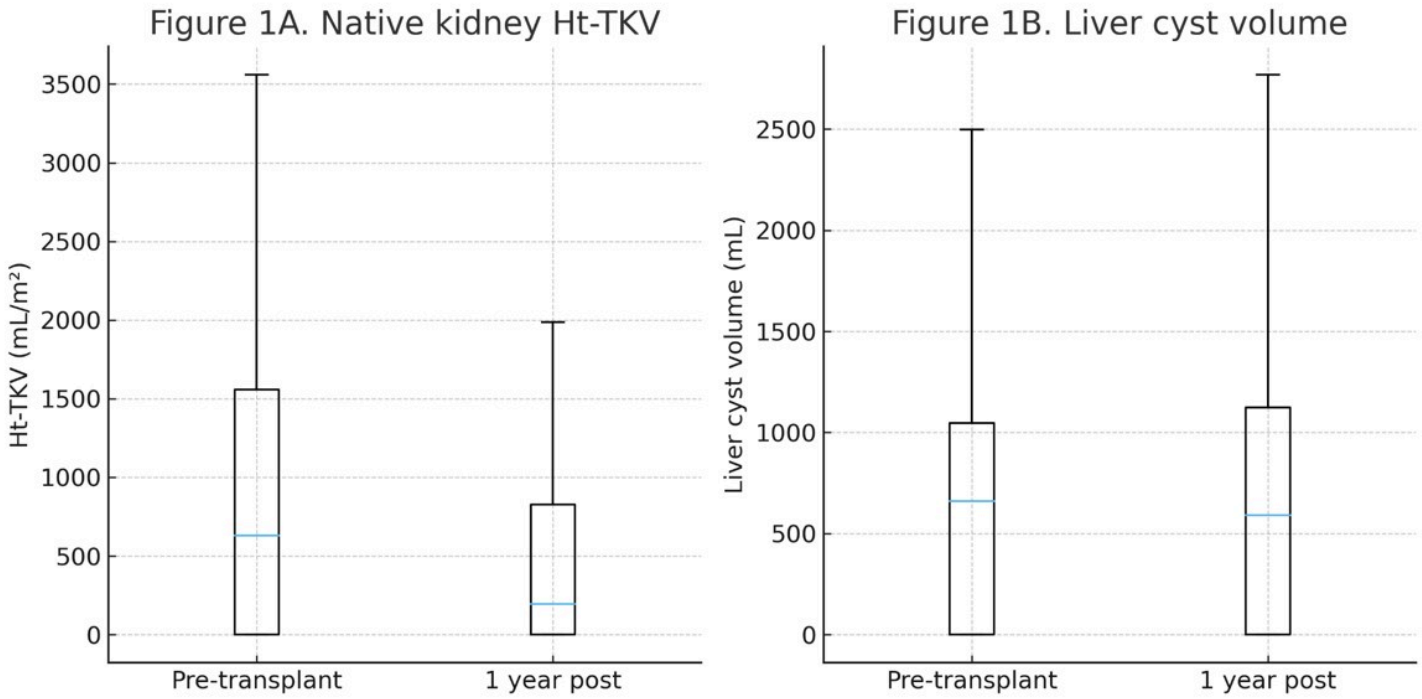


Figure 1

Changes in native kidney and liver cyst volume from baseline to one year post-transplant in patients with autosomal dominant polycystic kidney disease (ADPKD). (A) Native kidney height-adjusted total kidney volume (Ht-TKV) decreased significantly at one year (median 630.5 vs. 193.5 mL/m²; n=72). (B) Liver cyst volume showed modest reduction overall (median 661.0 vs. 591.0 mL; n=70). Boxplots represent medians (horizontal lines), interquartile ranges (boxes), and range (whiskers)

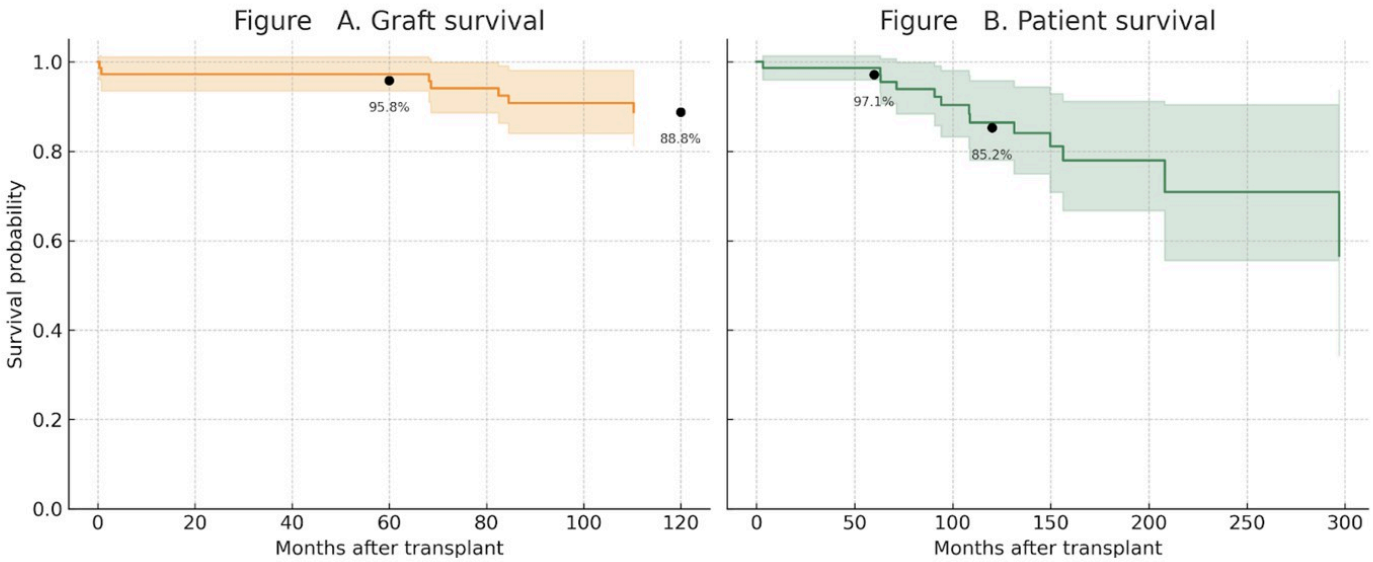


Figure 2

Kaplan–Meier survival curves for 72 ADPKD kidney transplant recipients. (A) Graft survival: 95.8% at 5 years and 88.8% at 10 years (7 graft losses). (B) Patient survival: 97.1% at 5 years and 85.2% at 10 years (13 deaths). Shaded areas denote 95% confidence intervals. Time origin is the date of transplantation; patients without events were censored at last follow-up (December 31, 2024).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTable1.docx