DOI: 10.15825/1995-1191-2025-2-23-30

KIDNEY TRANSPLANTATION IN PATIENTS WITH AUTOSOMAL DOMINANT POLYCYSTIC KIDNEY DISEASE: SURGICAL TACTICS, IMMEDIATE AND LONG-TERM OUTCOMES

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Introduction. Treatment and kidney transplantation (KT) for patients with autosomal dominant polycystic kidney disease (ADPKD) are associated with increased risks, particularly due to the potential for infection of polycystic kidney (PK) cysts. Currently, no standardized guidelines exist for the surgical management and pre-transplant preparation of these patients. **Objective:** to analyze the 15-year experience at a transplant center managing KT recipients with end-stage chronic kidney disease (eCKD) due to ADPKD. **Materials and methods.** A retrospective and prospective analysis was conducted on 132 ADPKD patients who underwent staged surgical treatment between 2008 and 2023. In the first stage, outcomes of 155 PK nephrectomies performed via laparoscopic and open approaches were evaluated. In the second stage, KT outcomes were assessed in 63 ADPKD recipients, comparing those with preserved native kidneys to those who had undergone nephrectomy. Additionally, as a control group, KT outcomes in 129 patients with eCKD of other etiologies from 2013 to 2023 were analyzed. **Results.** The study revealed significant advantages of laparoscopic access for PK nephrectomy, including a shorter length of stay in both intensive care and the hospital, as well as a lower complication rate (47.8% for laparotomy and lumbotomy approaches, and 12.8% for laparoscopic access). However, patients who underwent KT with preserved PK exhibited a higher incidence of infectious complications (26.9%), primarily due to cyst infections and resistance to standard antibiotic prophylaxis. Long-term graft survival was notably lower in this group, with a ten-year survival rate of 46.2%, compared to 73.1% in patients who had undergone nephrectomy and 74.1% in the comparison group. **Conclusion.** The integration of laparoscopic surgery for polycystic kidney disease into clinical practice has the potential to significantly reduce surgical complications and broaden the indications for PK nephrectomy. Among ADPKD patients who underwent nephrectomy, the post-transplant period was more favorable, with outcomes comparable to those of KT recipients with eCKD of other etiologies.

Keywords: autosomal dominant polycystic kidney disease, kidney transplantation, polycystic kidneys, laparoscopic access, nephrectomy.

INTRODUCTION

Autosomal dominant polycystic kidney disease (ADPKD) is a progressive disorder characterized by multiple bilateral cysts within the renal parenchyma, ultimately leading to impaired kidney function and, in many cases, the need for renal replacement therapy (RRT) [1–3]. By age 60, a significant portion of individuals with ADPKD experience end-stage chronic kidney disease (eCKD), and approximately 10–15% of those receiving maintenance dialysis via peritoneal dialysis fall into this category [2, 5].

In approximately 20% of individuals with polycystic kidney disease (PKD), kidney removal (nephrectomy) is considered due to clinical manifestations and complications. Due to the large size of polycystic kidneys (PK), many centers perform nephrectomy using laparotomy or lumbotomy approaches. These surgical interventions are associated with a high complication rate (up to 38%) and a mortality rate of up to 3% [1, 6].

Cyst infection is a serious complication of ADPKD, accounting for approximately 11% of hospitalizations in patients with this condition. In ADPKD patients, 30–50% experience kidney infections during their lifetime, and over 50% report one or more symptomatic infection episodes [7–9].

Laparoscopic nephrectomy for PKD was first performed in 1996, and is now widely used, offering the benefits associated with a minimally invasive procedure [2, 10].

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We have previously demonstrated that PKD has a high infection rate of 80%. The asymptomatic nature of ADPKD does not preclude the presence of infected small-diameter cysts [11]. The diagnostic capabilities of standard imaging modalities, such as spiral computed tomography and ultrasound remain limited in this context. Infection of renal cysts in PKD patients can worsen the prognosis of future kidney transplantation (KT). The presence of a non-sanitized focus of infection, combined with modern immunosuppressive therapy regimens, can lead to the development of a systemic inflammatory response and sepsis. Removal of polycystic kidneys to sanitize an active infection focus carries a high risk of complications and mortality [11–12].

To date, there are various approaches to the need for pre-transplant nephrectomy [13–19]. Our center uses a previously developed diagnostic and surgical preparation algorithm for KT in patients with ADPKD (Fig. 1), which is based on clinical presentation and comprehensive patient evaluation [20].

MATERIALS AND METHODS

The study is based on the results of the analysis of staged surgical treatment of 132 patients with PKD in the period from 2008 to 2023. The 15-year experience of the Center's work with this patient cohort was summarized and analyzed. Surgical preparation for transplantation from 2013 was performed according to the previously

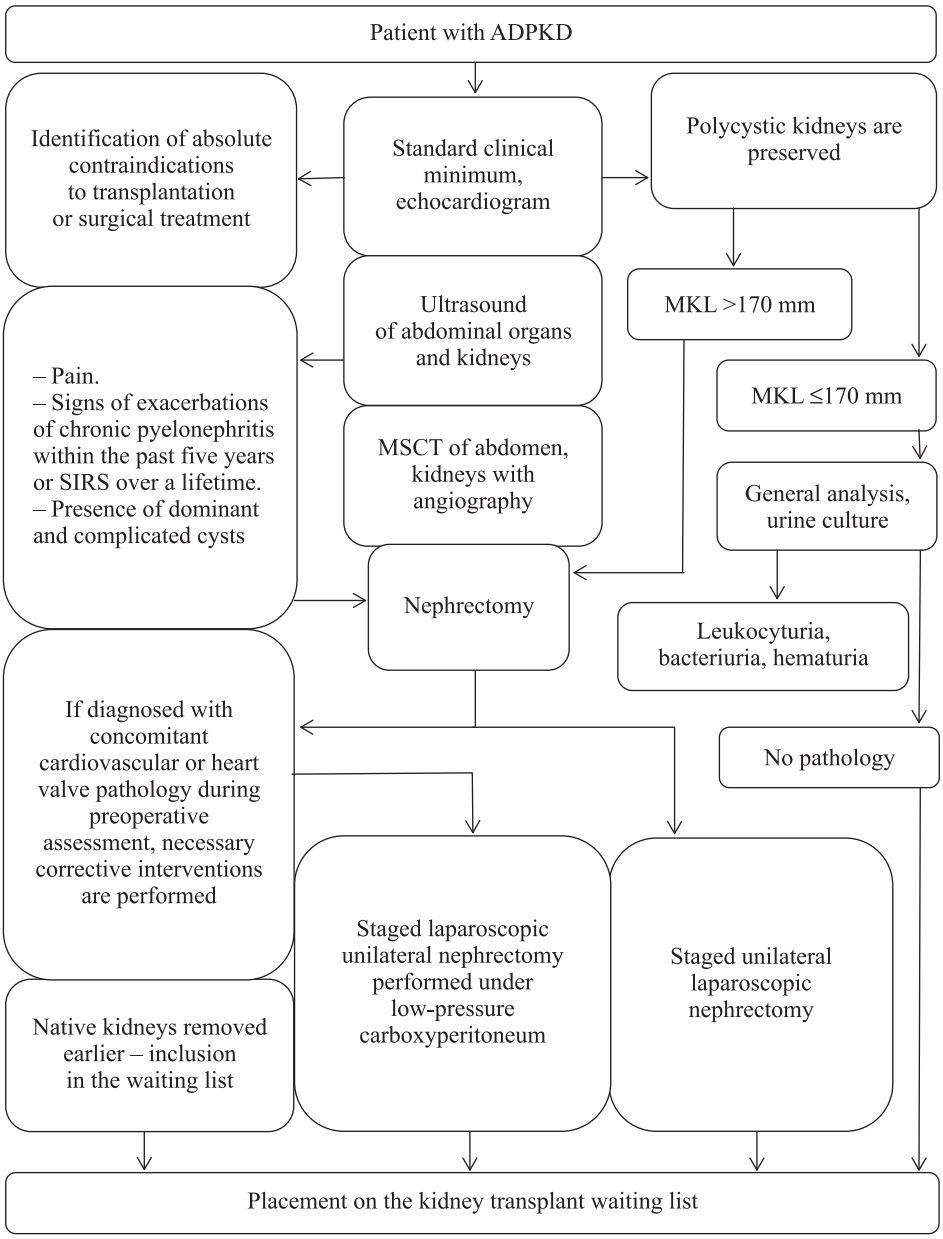


Fig. 1. Algorithm for inclusion in the kidney transplant waiting list for an ADPKD patient [21]. ADPKD, autosomal dominant polycystic kidney disease; SIRS, systemic inflammatory response syndrome; MSCT, multislice computed tomography; MKL, maximum kidney length

developed algorithm based assessment of clinical picture and maximum PKD size (Fig. 1).

For comparison, we analyzed KT outcomes in a control group of 129 patients with eCKD of other etiologies, treated between 2013 and 2023. Given the high risk of specific complications, patients with diabetes mellitus, repeat transplants, or rare genetic disorders were excluded from the study.

Between 2008 and 2023, a total of 155 nephrectomies were performed in 106 individuals as part of pre-transplant preparation or for clinical indications. Of these, 46 surgeries were carried out in 39 patients using either lumbotomy (for unilateral nephrectomy) or laparotomy (for bilateral nephrectomy). The remaining 67 patients underwent laparoscopic procedures, accounting for 109 nephrectomies in total. All laparoscopic interventions were unilateral.

Laparoscopic nephrectomies have been routinely performed since 2013, while the majority of open surgeries occurred prior to this period, due to their well-documented advantages. Surgical indications included preparation for KT and management of clinical symptoms of PKD such as hematuria, frequent recurrent pyelonephritis, and chronic pain.

The clinical characteristics of the patient cohorts and the outcomes of surgical treatment are presented in Table 1.

Between 2008 and 2023, 63 ADPKD patients underwent KT. Depending on whether native kidneys were preserved or removed, two groups of patients were distinguished:

– Group 1 (n = 26), patients who had preserved PKD at the time of transplantation.
– Group 2 (n = 37), patients who underwent nephrectomy before transplantation.

As a comparison group, we analyzed kidney transplant outcomes between 2013 and 2023 in 129 patients with eCKD of non-ADPKD etiology. All transplants were performed using immunologically compatible kidneys from brain-dead donors, following standard matching criteria. Baseline characteristics between the ADPKD and comparison groups showed no statistically significant differences (Table 2).

RESULTS

The outcomes of nephrectomy in patients with polycystic kidney disease are presented in Table 1. Notably, the laparoscopic approach was associated with a more favorable perioperative course. Although laparoscopic surgeries had a longer operative time, both intensive care

Table 1

Outcomes of polycystic kidney nephrectomy

Indicator	Nephrectomy (laparotomy, lumbotomy), n = 46	Laparoscopic nephrectomy, n = 109	P
Mean patient age (years)	53.2 ± 8.7	54.5 ± 8.1	p = 0.41
Patient gender – Male – Female	n = 39 21 (53.8%) 18 (46.2%)	n = 67 35 (52.2%) 32 (47.8%)	p > 0.05
Mean time to receive RRT by hemodialysis before surgery (months)	30.6 ± 19.3	38.5 ± 33.7	p = 0.141
Indications for surgical treatment – Clinical indications – Pre-transplant preparation	 31 (67.4%) 15 (32.6%)	 44 (40.4%) 65 (59.6%)	**p = 0.003**
Average surgery time (minutes)	118 ± 36.8	147.5 ± 57.5	**p = 0.003**
ICU length of stay (days)	2–3 days (2.9 ± 1.4)	1–2 days (1.1 ± 0.47)	**p = 0.001**
Bed-days spent in hospital (days)	14–16 (14.2 ± 5.7)	7–8 (8.5 ± 7.9)	**p < 0.001**
Surgical complication rate	47.8% (22)	12.8% (14)	**p < 0.001**
Arteriovenous fistula thrombosis	4.3% (2)	3.6% (4)	p = 1.000
SIRS, sepsis	10.8% (5)	3.6% (4)	p = 0.126
Intestinal paresis	10.8% (5)	–	**p = 0.002**
Wound suppuration	8.6% (4)	1.8% (2)	p = 0.064
Bleeding with hematoma formation in the postoperative wound and retroperitoneal space	8.6% (4)	2.7% (3)	p = 0.196
Additional surgical interventions	10.8% (5)	3.6% (4)	p = 0.126
Mesenteric thrombosis	0.0%	0.9% (1)	p = 1.000
Eventration	4.3% (2)	0.0%	p = 0.086
Access conversion	–	5.5% (6)	
Mortality	8.6% (4)	1.83% (2)	p = 0.064

Note: RRT, renal replacement therapy; ICU, intensive care unit; SIRS, systemic inflammatory response syndrome.

Table 2

Main characteristics and outcomes of kidney transplantation

Indicator	Group 1, n = 26	Group 2, n = 37	Comparison group, n = 129	P
Mean patient age (years)	49.8 ± 9.2	51.2 ± 10.5	47.8 ± 9.8	p > 0.05
Patient gender – Male – Female	 15 (57.7%) 11 (42.3%)	 21 (56.8%) 16 (43.2%)	 61 (47.3%) 68 (52.7%)	p > 0.05
Mean time to receive RRT by hemodialysis before surgery (months)	31.8 ± 27.6	41.8 ± 31.6	35.3 ± 28.4	p > 0.05
Donor characteristics				
Average age	51.2 ± 9.7	52.4 ± 10.1	49.4 ± 9.2	p > 0.05
Average creatinine level (μmol/L)	96.3 ± 12.1	103.5 ± 11.3	98.7 ± 9.4	p > 0.05
Average number of HLA matches	4.1 ± 1.2	4.3 ± 0.9	3.9 ± 1.1	p > 0.05
Kidney transplant outcomes				
Graft function: – Immediate – Delayed	 14 (53.8%) 12 (46.2%)	 22 (59.4%) 15 (40.6%)	 76 (58.9%) 53 (41.1%)	p > 0.05
Early complications (within 1 month of transplantation)				
Primary non-function	1 (3.8%)	0.0%	3 (2.3%)	p > 0.05
Acute transplant rejection	1 (3.8%)	1 (2.7%)	3 (2.3%)	p > 0.05
Infectious complications of various localizations	7 (26.9%)	2 (5.4%)	8 (6.2%)	**p < 0.05**
Nephrectomy due to infected cysts	2 (7.6%)	–	–	–
Late complications				
Transplant rejection	2 (7.6%)	3 (8.1%)	9 (6.9%)	p > 0.05
Pyelonephritis, episodes of hematuria, leukocyturia (number of cases per year)	1.9 ± 0.71	0.21 ± 0.11	0.23 ± 0.15	**p < 0.05**
Post-transplant nephrectomy according to clinical indications	4 (15.4%)	–	–	

Note: RRT, renal replacement therapy.

unit (ICU) and overall hospital stays were significantly shorter compared to open surgery. The incidence of postoperative complications in the laparoscopic group remained low, not exceeding 13%.

Transplant outcomes in the analyzed groups are presented in Table 2.

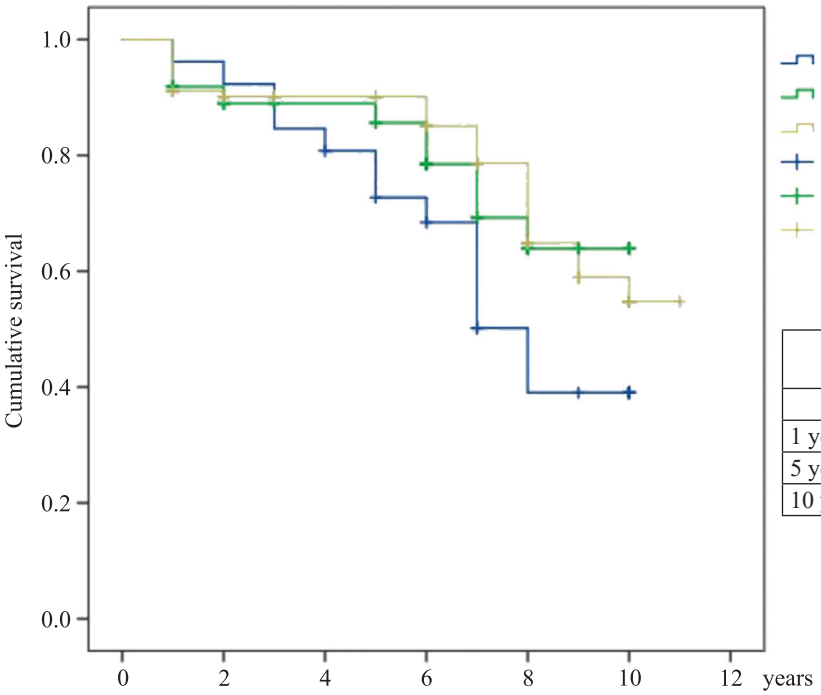
Infectious complications of various localizations included pneumonia, sepsis, graft pyelonephritis, postoperative wound suppuration, and infection of cysts in preserved native kidneys. A notable increase in the frequency of complications was observed in patients with preserved polycystic kidneys (PK), primarily due to cyst infections and the presence of pathogens resistant to standard antibiotic prophylaxis. For group 1, the incidence of infectious complications was 26.9%, p = 0.028 when comparing group 1 and group 2, and p = 0.004 when comparing group 1 and comparison group. Additionally, Group 1 showed a significantly higher frequency of leukocyturia (more than 20 leukocytes per field of view) and hematuria (more than 20 red blood cells per field of view). In seven cases, nephrectomy of native kidneys was required post-transplant due to PKD-related complications. Overall, among all ADPKD patients who underwent KT, the native kidney was removed in 69.8% (44 cases), predominantly due to infectious complications.

Ten-year kidney graft and recipient survival rates are shown in Figs. 2 and 3. Notably, 10-year graft survival was 46.2% in group 1, compared to 73.1% and 74.1% in group 2 and comparison group, respectively.

DISCUSSION

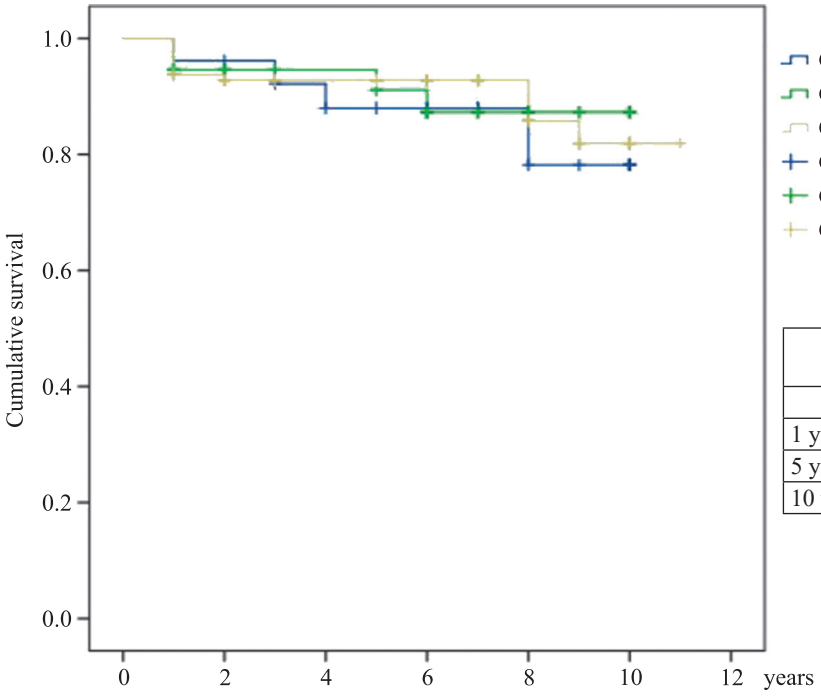
The high infection rate of 80% in PKD does warrant the expansion of indications for nephrectomy during the pre-transplantation preparation stage [11]. Effective treatment of non-sanitized infections during pre-transplant preparation is challenging. This makes managing infections both before and after transplantation more difficult. Simultaneous nephrectomy with kidney transplantation for PKD patients is a common procedure today. In our opinion, this practice is doubtful, as the large volume of surgery and high risk of infectious complications jeopardize the fate of the graft and the life of the recipient [21–23].

The use of laparoscopic technologies in PKD surgery has significantly broadened the indications for pre-transplant nephrectomy by reducing the risks associated with surgical intervention. Native kidney removal is required in 69.8% of ADPKD patients for various clinical reasons. In 21.7% of cases, nephrectomy became necessary after transplantation due to PKD-related complications that developed under immunosuppressive therapy.



	Group 1	Group 2	Comparison group
Graft survival (%)			
1 year	92.3	94.5	96.3
5 years	76.9	81.1	83.2
10 years	462	73.1	74.1

Fig. 2. Cumulative kidney graft survival (p = 0,063)



	Group 1	Group 2	Comparison group
Recipient survival (%)			
1 year	92.3	97.2	96.4
5 years	88.5	91.8	92.8
10 years	84.6	89.2	88.3

Fig. 3. Cumulative survival of kidney transplant recipients (p = 0.531)

The use of laparoscopic techniques for polycystic kidneys in ADPKD has allowed for safer pre-transplant nephrectomies by minimizing the risks of surgical intervention. Removal of native kidneys for various reasons was required in 69.8% of patients with ADPKD. In 21.7% of cases, nephrectomy was performed post-transplantation due to PKD-related complications while the patients were on immunosuppressive therapy.

Bilateral nephrectomy should be considered in select cases. At our center, conversion to an alternative surgical approach was necessary in cases involving a horseshoe kidney or insufficient "working space" in the abdominal cavity due to the giant size of the kidneys.

Patients with ADPKD have a significantly higher frequency of various cardiovascular pathologies compared to the general population of patients with eCKD. Preparation of each patient in this group should include

a comprehensive cardiological examination. In cases where concomitant cardiovascular pathology is detected, nephrectomy under low-pressure carboxyperitoneum is available [24].

Notably, after 10 years, only 46.2% of grafts in patients with preserved PKD remained functional, and the mortality rate in this group reached 15.4%. In contrast, PKD patients who underwent pre-transplant nephrectomy had a more favorable postoperative course, with significantly lower rates of leukocyturia, bacteriuria, and hematuria.

At the same time, total native nephrectomy of all kidneys with cystic changes should be excluded. Maximum kidney length (MKL) measured by spiral computed tomography (SCT) serves as a reliable threshold. Mathematically, this parameter is a strong predictor of complications and the need for nephrectomy, offering a straightforward and easily calculable metric via SCT. According to earlier studies, an MKL of 170 mm is considered the optimal threshold for nephrectomy in cases of asymptomatic disease progression [25]. At the same time, in the presence of pain syndrome or signs of kidney and urinary tract infection, PKD size is not a determining factor, and laparoscopic nephrectomy is indicated [25].

CONCLUSION

Laparoscopic techniques can broaden indications and minimize surgical risks in the treatment and pre-transplant preparation of ADPKD patients on the KT waiting list. KT outcomes in ADPKD patients are comparable to those in patients with eCKD from non-ADPKD causes. Patients who had polycystic kidney removed had a more favorable post-transplant period due to a lower incidence of infectious complications. Given the necessity of renoprivation in ADPKD patients, they should be prioritized in the selection of KT recipients.

The authors declare no conflict of interest.

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The article was submitted to the journal on 25.09.2024