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CADAVERIC KIDNEY ALLOTRANSPLANTATION AT KRASNOYARSK REGIONAL CLINICAL HOSPITAL

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Objective: to evaluate the early and long-term outcomes of cadaveric kidney allotransplantation (CKAT) based on a retrospective analysis of 71 cases treated at Krasnoyarsk Regional Clinical Hospital (KRCH). **Materials and methods.** From March 2014 to June 2019, 71 kidney transplants were performed at KRCH – 42 (59.15%) men and 29 (40.85%) women. The age of the patients varied from 20 to 59 years (mean age 39.6 ± 8.14 years). The causes of end-stage chronic kidney disease which subsequently led to CKAT were chronic glomerulonephritis, chronic tubulointerstitial nephritis, hypertensive nephropathy (HN), diabetic nephropathy resulting from type I diabetes (DN), nephropathy of mixed genesis (HN + DN), vesicoureteral reflux, congenital angiodysplasia of the kidneys, and Alport syndrome. The mean number of HLA mismatches was 4.5 ± 0.9. **Results.** Hospitalization lasted for an average of 34.05 ± 9.56 days. Primary function was observed in 32 (45.08%) patients, while 39 (54.92%) cases had delayed function. Post-transplant complications were noted in 23 (32.39%) patients, of whom 12 (16.9%) had early post-transplant complications, while 15 (21.13%) encountered complications in the late post-transplant period. The most frequently diagnosed were immunological, infectious, and urological complications. Vascular, surgical, oncological, and other complications were less frequent. The annual graft survival rate was 87.3%. Patient survival rate was 95.77%. One (1.4%) and 2 (2.81%) patients died in the early and late post-transplant periods, respectively. Hospital mortality – 1 case (1.4%). **Conclusion.** Kidney transplantation is the most effective treatment for patients with irreversible chronic kidney disease. About 87.33% of transplants were found to be effective. However, 32.39% of patients had postoperative complications. The vast majority of complications were reversible and were corrected conservatively or surgically. Nevertheless, graft loss occurred in 12.67% of cases. The success of transplantation depends on a number of factors related to both the donor and the recipient, as well as the immunological status and surgical technique. A personalized approach to recipients helps to reduce postoperative complications, prevent nephrotoxicity and rejection reactions.

Keywords: kidney transplantation, chronic kidney disease.

INTRODUCTION

Intensification of transplantation activity and making of progress in the organization of organ donor processes are the most promising solution to the problem posed by a steady increase in the number of patients with end-stage chronic kidney disease (CKD) [1, 2].

Trends in modern medicine are such that kidney transplantation provides better long-term outcomes compared to other renal replacement therapy methods in end-stage CKD. Survival rates of kidney recipients are higher than those of patients on long-term hemo- or peritoneal dialysis [3].

Kidney transplantation is highly effective not only socially, but also economically. Over a three-year period, the cost of providing one CKD patient with hemodialysis is higher than that of a renal transplant patient [4].

Deceased-donor kidney transplant was performed for the first time in Krasnoyarsk Krai in March 2014 at the Krasnoyarsk Regional Clinical Hospital (KRCH) in Krasnoyarsk, Russia. From March 2014 to June 2019, 71 cadaveric kidney transplants were performed; the number of such surgeries is increasing annually.

Along with development of the donor service, the number of donor bases has increased from 1 in 2014 to 7 in 2019. The region had 23.8 donors per million population in 2018 [5]. Today, 8.8% of patients on hemo- and peritoneal dialysis are on the active waiting list for kidney transplantation at KRCH. The average waiting time for a donor kidney is 286 days.

So, it is obvious that there is not just a high demand for kidney transplantation in Krasnoyarsk Krai, but also a significant demand for transplantation and donor services.

OBJECTIVE

The aim of this study is to evaluate the early and long-term outcomes of cadaveric kidney allotransplantation

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(CKAT) based on a retrospective analysis of 71 cases treated at KRCH in Krasnoyarsk.

MATERIALS AND METHODS

We conducted a retrospective analysis of the treatment of 71 patients aged 20 and above, who underwent CKAT from March 2014 to June 2019 at the 2nd surgical ward of KRCH in Krasnoyarsk (Fig. 1).

The work of the KRCH transplant service is carried out in accordance with the standards and clinical guidelines for kidney donation and transplantation adopted by the Russian Transplant Society [6, 7].

The donor service at KRCH was assessed. Forty-eight patients were effective donors. The main reasons for exclusion from being a donor were identified infectious diseases, increasing phenomena of multiple organ failure syndrome, cardiac arrest during follow-up, and identified intraoperative focal organ tumors. The average age of effective donors was 44.17 ± 8.07 years. Azotemia values were as follows: creatinine 92.33 ± 20.27 mmol/L, urea 5.47 ± 1.74 mmol/L, potassium 3.7 ± 0.43 mmol/L.

The CKAT waiting list was analyzed. While being placed on the waiting list, 26 (36.62%) patients had anuria, 32 (45.08%) had oliguria, and 13 (18.3%) were diagnosed with preserved diuresis. Before transplantation, 67 (94.36%) patients underwent renal replacement therapy using hemodialysis. Dialysis time in recipients ranged from 0 (4 patients (5.66%) were operated on at the pre-dialysis stage) to 120 months, averaging 33.59 ± 23.87 months.

Among the recipients, men accounted for 59.15% (n = 42), while women were 40.85% (n = 29). The age of the patients varied from 20 to 59 years (mean age 39.6 ± 8.14 years). The main characteristics of the recipients are presented in Table.

Table

Demographics of kidney recipients

Indicator	Number of recipients	%
Donor age, years Range (average) 20–59 (39.6 ± 8.14)		
20–29	10	14.1
30–39	25	35.2
40–49	22	31.0
50–59	14	19.7
Donor gender (f/m)	29/42	

The causes of end-stage CKD and further CKAT were: chronic glomerulonephritis (CGN) (57, 80.28%), chronic tubulointerstitial nephritis (CTN) (5, 7.04%), hypertensive nephropathy (HN) (4, 5.63%), diabetic nephropathy (DN) (1, 1.4%), nephropathy of mixed genesis (HN + DN) (1, 1.4%), vesicoureteral reflux (VUR) (1, 1.4%), congenital renal angiodysplasia (CRAD) (1, 1.4%), Alport syndrome (1, 1.4%).

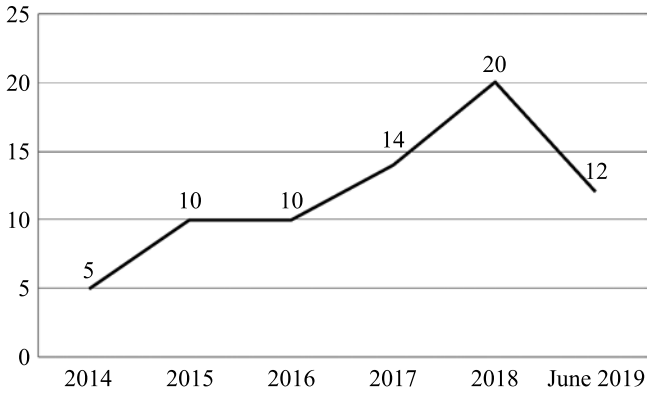

Fig. 1. Number of cadaveric kidney allotransplantations performed during the study period

The list of studies corresponded to the standard set of diagnostic measures approved by the Russian Transplant Society; all patients on the CKAT waiting list were subjected to HLA typing and HLA antibody titer determination [7]. The average number of HLA mismatches was 4.5 ± 0.9.

The laboratory values of the general blood analysis of recipients had no significant deviations: red blood cell – 3.78 ± 0.48 × 10^{12}/L, hemoglobin – 118.84 ± 13.47 g/L, white blood cells – 7.52 ± 1.67 × 10^{9}/L, platelets – 205.32 ± 45.4 × 10^{9}/L.

Azotemic indicators had a fairly high range of values: urea – 15.07 ± 6 mmol/L, creatinine – 663.77 ± 175.79 μmol/L. This was primarily due to the different periods of dialysis duration and technique, as well as the analysis time.

Standard cross-over heterotopic kidney transplantation was performed in 68 (95.77%) patients (right to left 23 (32.39%) kidneys, left to right 45 (63.38%) kidneys). In 3 (4.22%) cases, an organ-side transplant was performed (right to right 1 (1.4%) kidney, left to left 2 (2.82%) kidneys). Access in these cases was chosen due to the impossibility of performing cross-sectional transplantation for various reasons: early transplanted pancreas, inability to access the main vessels, etc.

An overwhelming number of kidneys (52 transplants (73.24%)) had standard anatomy. However, 13 kidneys had vascular features: 11 (15.5%) organs had 2 renal arteries (RAs); 1 (1.4%) – 2 RAs and 2 renal veins (RVs) and in 1 (1.4%) case – 3 RVs. In addition, 5 (7.04%) kidneys had cysts, which was subsequently confirmed histologically; in 1 (1.4%) case, an up to 7 mm bulk lesion was revealed, which was verified as a papillary adenoma during an urgent intraoperative pathomorphological examination in order to rule out malignant tumor of the kidney. One kidney (1.4%) had a complete doubling of the pelvicalyceal system with a complete doubling of the ureter.

The revealed features of angioarchitectonics in 6 (8.45%) cases required reconstructive surgery: 3 (4.22%)

cases – the accessory RA was anastomosed end-to-side with the main RA; 1 (1.4%) case – 2 RAs on the site were reconstructed into 1 RA on a common site of smaller size; 2 (2.81%) cases – short RV was lengthened using a portion of the inferior vena cava.

The detected tumors in donor organs also required additional surgical manipulations: kidney cysts were detected in 5 (7.04%) cases, walls of the cysts were excised, in 1 (1.4%) graft with an up to 7 mm bulk lesion, a wedge-shaped kidney resection was performed.

All patients underwent standard heterotopic renal transplantation to the iliac area. The average duration of the operation was 191.27 ± 28.4 minutes. Intraoperative blood loss averaged 222.53 ± 76.95 mL.

The vast majority of transplants were performed using the standard technique consisting of RA anastomosis with the external iliac artery (ELA) in an end-to-side manner in 62 (87.32%) cases, while in 9 (12.67%) cases, anastomosis was made with the internal iliac artery (ILA) by the end-to-end technique due to the impossibility of matching the ELA and RA diameters. The RVs were in all cases anastomosed with the external iliac vein end-to-side. Ureteroneocystoanastomosis in all cases was performed according to the Lich-Gregoir procedure with double-J stent. Average duration of conservation was 439.46 ± 128.35 minutes.

Immunosuppression was induced taking into account the immunological risk (PRA level, number of HLA mismatches, recipient age): in 64 (90.14%) cases, induction was performed according to the Basiliximab + Methylprednisolone scheme; in 5 (7.04%) cases, due to a high immunological risk and high PRA level, induction was performed with Thymoglobulin + Methylprednisolone; in 2 (2.81%) cases, induction with methylprednisolone was done.

Immunosuppressive therapy was initiated according to a standard 3-component scheme: calcineurin inhibitors (CIs), MMF and glucocorticosteroids. In 68 (97.18%) cases, Tacrolimus + Mycophenolic acid + Methylprednisolone; in 3 (2.8%) cases, Cyclosporin + Mycophenolic acid + Methylprednisolone; two patients had already received immunosuppressive therapy with Cyclosporin – due to previous transplantation, it was decided not to convert; one patient converted from tacrolimus to cyclosporine due to development of post-transplant diabetes mellitus.

RESULTS

The effectiveness of surgical interventions was evaluated based on the peculiarities of the course and development of post-transplant complications. It was divided into early (≤3 months after surgery) and late (>3 months after surgery).

Laboratory parameters were monitored daily in the early postoperative period. A fall in hemoglobin levels was observed, which reached its minimum values by day 3, then it was restored. Increased manifestations of anemia were observed in 15 (21.12%) patients, which required an average of 877.33 ± 369.46 mL in blood transfusion. This was probably due to the development of hemorrhagic complications like intraoperative bleeding, parenchymal and wound bleeding in the early postoperative period, and hemostasis defects during hemodialysis sessions.

In accordance with clinical guidelines, on day 1 after CKAT, all patients underwent standard determination of calcineurin inhibitor blood concentration at the rate of 0.1–0.2 mg/kg/day every other day until the end of hospitalization (Fig. 2). The average tacrolimus levels from day 1 to day 15 corresponded to the target levels after CKAT (8–15 ng/ml). An increase in concentration by day 3 was associated with initiation of immunosuppressive therapy and subsequent dose adjustment [8].

White blood cell (WBCs) and potassium levels decreased to minimum values by day 5, after which they increased.

In the first 2 days, patients showed increased WBC levels, with a subsequent decrease to minimum values by day 5, which may correspond to a period of high concentration of immunosuppressants in the blood [9]. After dosage adjustment, WBC levels reached normal values.

Creatinine content steadily decreased from 624.22 ± 196.85 μmol/L on day 1 to 222.01 ± 116.43 μmol/L on day 15 day after surgery. Urea concentration increased from 18.57 ± 5.38 mmol/L on day 1 to 19.67 ± 5.22 mmol/L on day 2, and for three days there was almost no change (19.51 ± 7.14 mmol/L on day 5), after which urea level gradually decreased to 14.44 ± 5.63 mmol/L on day 15 (Fig. 3).

An increase in urine output was noted in the first 5 days after surgery from 1481.37 ± 1189 mL to 2806.27 ± 1539.68 mL by day 5, then urine output decreased, reaching normal values by day 10 and day 15

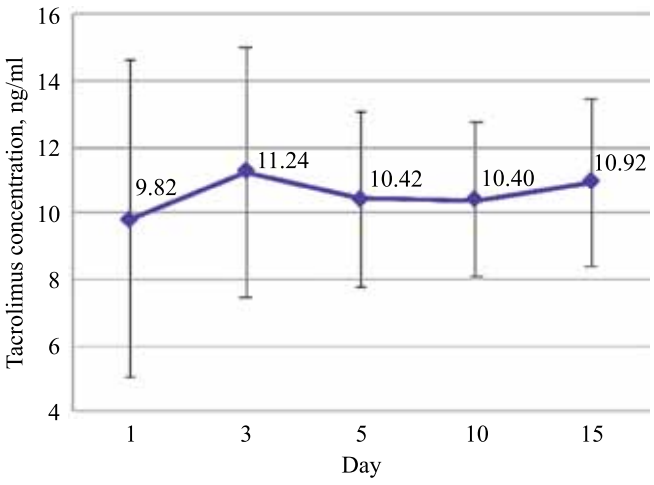

Fig. 2. Tacrolimus concentrations after surgery

(2484.26 ± 910.75 mL and 2463.28 ± 835.57 mL, respectively) (Fig. 4).

Ultrasound examination was carried out during week 1 every day, and then once every second day starting from week 2 till the end of hospitalization. Renal graft sonography in the early days showed a slowdown in RA blood flow up to day 5. Blood flow velocity in the RA increased in the following days. Blood flow velocity in the segmental artery (SA) and arcuate artery (AA) increased throughout the entire follow-up period (Fig. 5). Average renal speed indicators were within normal limits [10, 11].

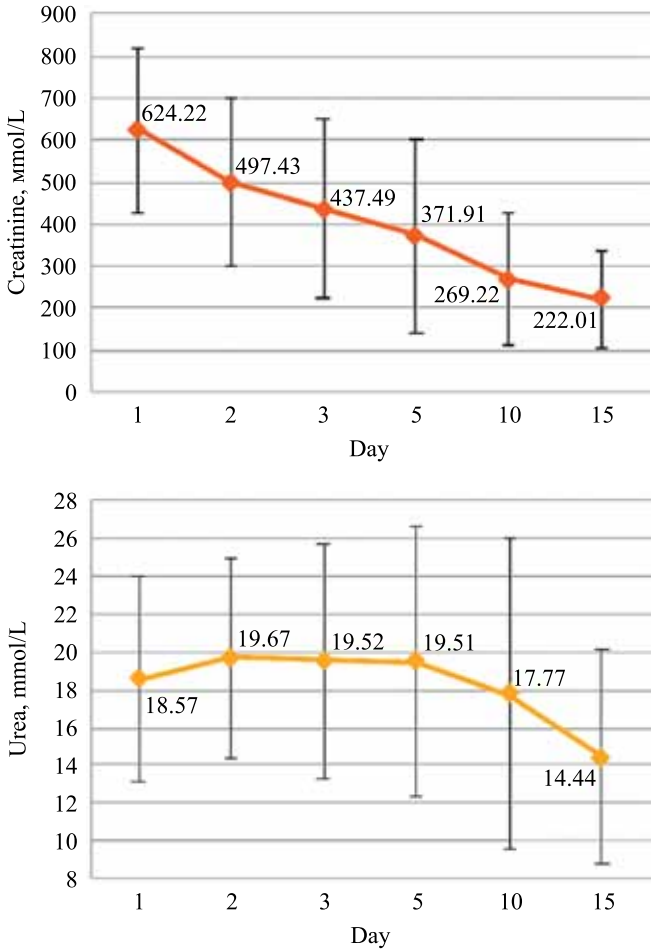

Fig. 3. Postoperative azotemic indicators

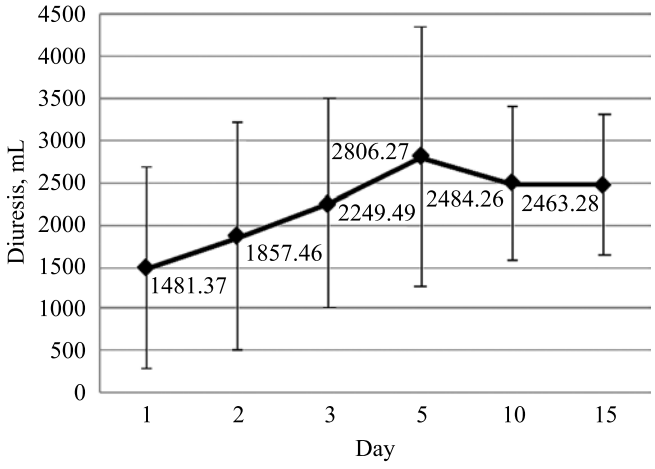

Fig. 4. Postoperative diuresis

Resistive indices RA and SA increased in the first 3 days, and then decreased in subsequent days. The AA resistive index decreased throughout the observation period (Fig. 6). The average values of the resistive indices were within the reference values [10, 11].

Drains were removed at postoperative day 4.22 ± 0.81, the urethral catheter at postoperative day 8.35 ± 1.52, and the ureteral stent at postoperative day 27.67 ± 6.27.

The average duration of hospitalization was 34.05 ± 9.56 days.

Primary function was observed in 32 (45.08%) patients, while delayed function was noted in 39 (54.92%) patients. The criterion for delayed function included one or more hemodialysis sessions in the first 7 days after surgery [12]. Hemodialysis sessions were performed in 39 patients in numbers ranging from 1 to 18, on average 3.34 ± 2.18.

Postoperative complications were divided into several types: immunological (9.85%), infectious (8.45%), urological (7.04%), vascular (5.63%), surgical (2.81%), oncological (2.81%) and others (4.22%).

Post-transplant complications were recorded in 23 (32.39%) patients, of which 11 (15.49%) had the complications **in the early post-transplant period**.

Among immunological complications, acute cellular rejection was most common (n = 3; 4.22%), which in all cases was stopped by a course of methylprednisolone pulse therapy in a total dose of 1.5–2.0 g. Acute humoral graft rejection in all cases (n = 2; 2.81%) resulted in graftectomy.

Vascular complications (n = 2; 2.81%) were associated with renal vein thrombosis of the graft and resulted in graftectomy. Surgical complications (n = 2; 2.81%): postoperative wound hematoma – revision, wound debridement was performed; subcapsular hematoma rupture with massive bleeding – graftectomy was performed.

Post-transplant tacrolimus-induced diabetes mellitus developed in 1 (1.4%) patient; according to recommendations, tacrolimus was converted to cyclosporine with a positive effect [13, 14]. Acute nephrotoxicity caused by CIs and confirmed histologically was recorded in one patient, which required a dose adjustment of the immunosuppressive drug with a positive effect.

Fifteen (21.13%) patients had a complicated **late post-transplant period**.

Immunological complications (n = 2; 2.81%): in 1 (1.4%) case, acute cellular rejection was diagnosed, arrested conservatively, in another 1 (1.4%) patient – chronic steroid-resistant graft rejection with loss of graft function. Vascular complications (n = 2; 2.81%): RA stenosis – graft artery was stented; renal artery thrombosis – graftectomy was performed.

Urological complications (n = 5; 7.04%): 2 (2.81%) patients had VUR, 1 (1.4%) patient underwent transurethral correction of the ureteral orifice. One (1.4%) patient developed purulent graft pyelonephritis, conservative measures had no effect, sepsis, graftectomy, death on day 187 after transplantation. Ureteral obliteration (n = 1; 1.4%) – laser ureterotomy was performed with a positive outcome. Ureterocystoanastomosis stricture (n = 1; 1.4%) required neoureterocystoanastomosis. A possible cause of complications associated with development of ureteral stricture is due to disruption in its blood supply against the background of acute cellular rejection previously suffered in these patients [15, 16 [15, 16].

Oncological complications (n = 2; 2.81%): one patient developed Kaposi's sarcoma; conservative therapy gave a positive trend – tumor regression. Prostate cancer T1M0N0 was diagnosed a year later in one patient after performing transurethral resection of the prostate against the background of increasing infravesical obstruction; small acinar adenocarcinoma was diagnosed on the basis of pathomorphological examination of the surgical material. In both cases, conversion from MMF to everolimus was performed.

Infectious complications (n = 6; 8.45%): in 5 (7.04%) cases, CMV viremia, in 1 (1.4%) case, hepatitis B reactivation – antiviral therapy was prescribed.

Acute nephrotoxicity caused by CIs developed in 1 (1.4%) patient. The immunosuppressive drug dose was adjusted with a positive effect.

Drug-induced ulcerative colitis (UC) in 1 patient required withdrawal of the immunosuppressive drug,

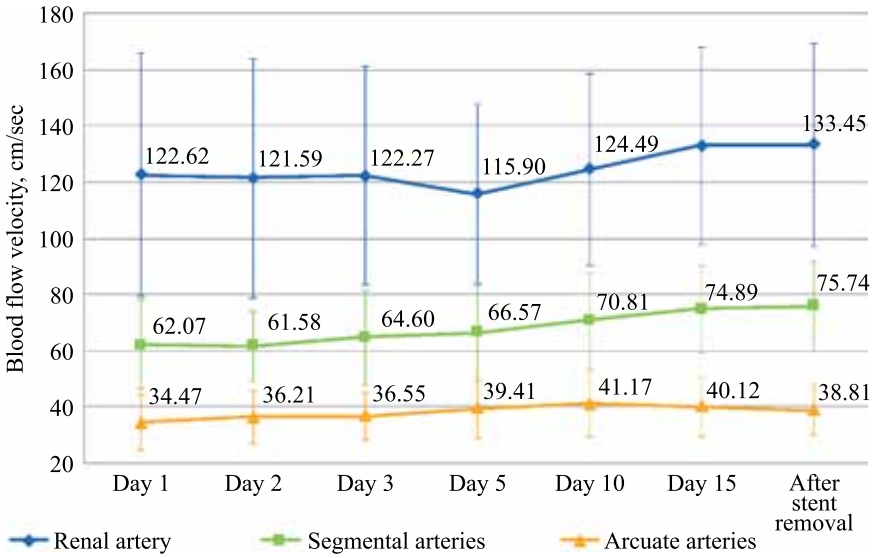

Fig. 5. Blood flow velocity indicators according to graft sonography

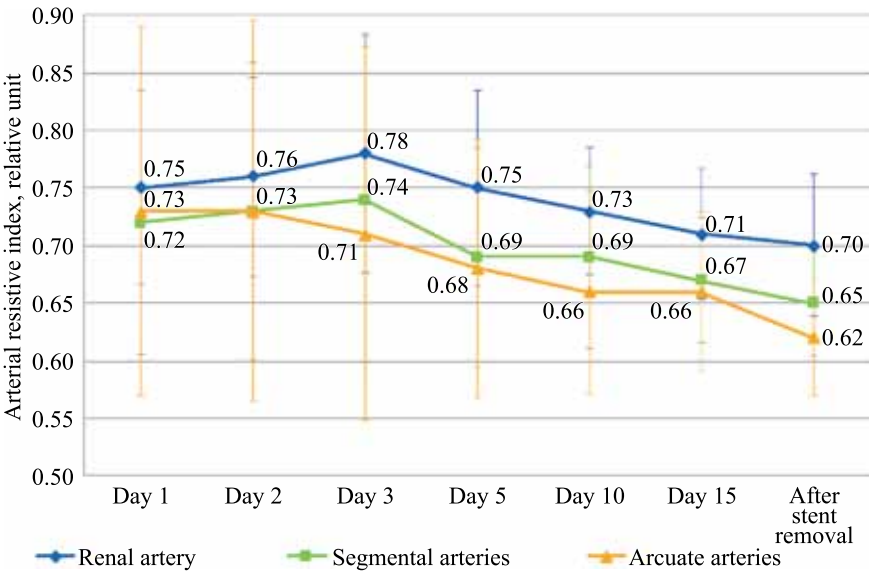

Fig. 6. Renal arterial resistive index according to sonography data

against which the UC phenomena subsided, but later there was loss of graft function.

Combinations of complications were conditionally divided into monospecific, when complications of one type developed, and polyspecific, combining complications of 2 or more types.

Monospecific complications were recorded in 19 (26.76%) patients, 3 (4.22%) patients had a combination of 2 types of complications, and 2 (2.8%) patients had polyspecificity, combining 3 or more types. At the same time, a combination of complications could develop both during either or both postoperative periods.

The 1-year and 5-year graft survival after CKAT were 87.3% and 73.51% respectively. Loss of graft function predominantly occurred in the 5th year after surgery (after 48 months) (Fig. 7).

The group of patients with 3 or more HLA matches (n = 12) had a higher percentage of primary function compared to the group of patients with 2 or less HLA matches (n = 59) (58.33% and 42.37% respectively), as well as the best 3-year survival rate (100% and 85.9%, respectively) (Fig. 8).

Graftectomies were performed in 9 (12.67%) patients. In the early post-transplant period (up to 3 months after surgery), grafts were removed in 4 (5.63%) patients, while in the late post-transplant period, 5 (7.04%) patients had graftectomy. The reasons for graftectomy were surgical, immunological, vascular, and urological complications.

Patient survival rate was 95.77% (68 patients) (Fig. 9).

One patient died at the early post-transplant period; 2 (2.81%) patients died at the late post-transplant stage. Hospital mortality was 1 case (1.4%), the cause of death was sepsis against the background of acute purulent graft pyelonephritis. In 2 (2.81%) cases, the cause was acute cardiovascular failure due to acute coronary syndrome (ACS).

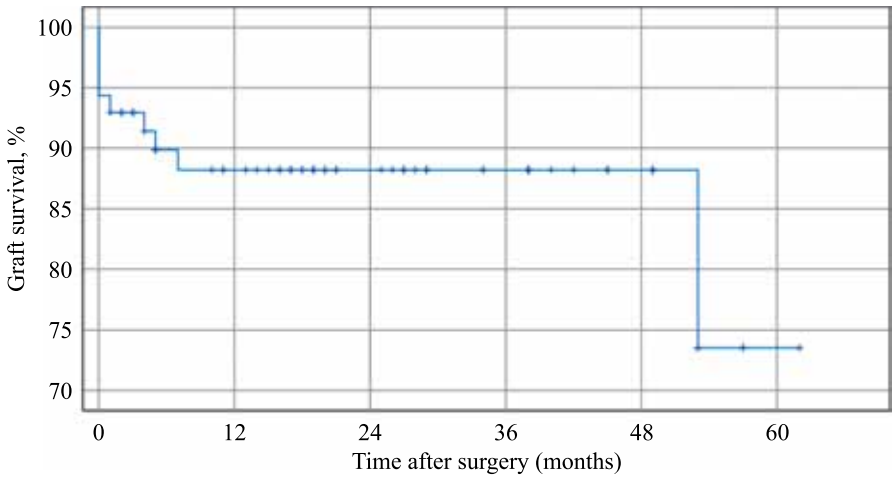

Fig. 7. Graft survival

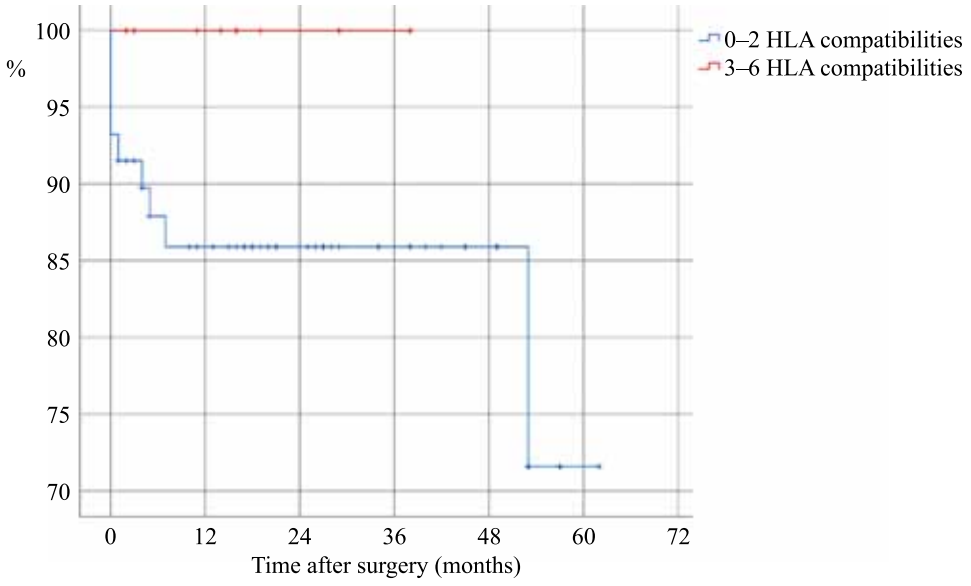

Fig. 8. Graft survival depending on the number of HLA matches

This is consistent with reports indicating that deaths after kidney transplantation are often due to cardiac pathology [17].

DISCUSSION

Analyzing the results obtained, we can identify a number of factors influencing the outcome, graft functionality and development of complications.

Post-transplant complications that developed in 23 (32.39%) patients had an adverse effect on graft function: of them, 11 (15.49%) in the early post-transplant period, and 15 (21.13%) in the late post-transplant period. Complications were divided into several types: immunological (9.85%), infectious (8.45%), urological (7.04%), vascular (5.63%), surgical (2.81%), oncological (2.81%) and others (4.22%).

Donor factor

When evaluating effective donors, it was noted that the mean age was 44.17 ± 8.07 years, and azotemia indicators were within reference values: creatinine 92.33 ± 20.27 μmol/L, urea 5.47 ± 1.74 mmol/L, potassium 3.7 ± 0.43 mmol/L.

An important factor influencing outcome is the duration of preservation. Prolonged cold ischemia time is a recognized risk factor for graft dysfunction. Maximum reduction in cold ischemia time is one of the clinically feasible options for prevention of graft dysfunction [18]. The graft preservation period in the analyzed patients was 439.46 ± 128.35 minutes.

In addition, it should be noted that 26.76% of the donor organs had vascular features, development of the pelvicalyceal system and the ureter, tumors that required reconstructive surgery. 18.3% of the kidneys had vascular features, but vascular reconstruction was required only in 8.45% of cases. Renal parenchymal tumors were detected both preoperatively and intraoperatively in 6 (8.45%) cases. When kidney cysts were detected (n = 5; 7.04%), the walls of the cysts were excised, followed by histological examination; in all cases, benign nature was confirmed. Intraoperatively, when processing 1 (1.4%) graft, a tissue formation up to 7 mm in size was detected, a wedge-shaped kidney resection was performed with urgent pathomorphological examination – papillary renal adenoma was verified.

The relationship of change in creatinine difference between recipients on day 15 and the donor was 94.14 ± 75.16 μmol/L, with a donor-recipient creatinine difference of 142.87 ± 102.50 μmol/L for donors 45 years old and above, and 58 ± 39.57 μmol/L for 44 years old and younger.

Recipient factor

Patient age, etiology of CKD, and comorbidity are important predictors of CKAT outcome. Recipients ranged in age from 20 to 59 years (mean age 39.6 ± 8.14 years). The main pathologies that caused CKD and further CKAT were: CGN (57 patients, 80.28%), CTN (5 patients, 7.04%), HN (4 patients, 5.63%), DN (1 patient, 1.4%), mixed nephropathy (1 patient, 1.4%), VUR (1 patient, 1.4%), CRAD (1 patient, 1.4%), and Alport syndrome (1 patient, 1.4%). The baseline azotemic values of the recipients before CKAT and the dialysis duration of recipients play a significant role in the postoperative period. The mean uremic values of those studied were: urea 15.07 ± 6 mmol/L, creatinine 663.77 ± 175.79 μmol/L; the fairly large range of values is primarily associated with the dialysis method and various dialysis durations, which ranged from 0 (4 patients were operated on at the pre-dialysis stage) up to 120 months (mean 33.59 ± 23.87 months). Postoperative hemodialysis sessions were required for 39 patients, ranging from 1 to 18, on average 3.34 ± 2.18.

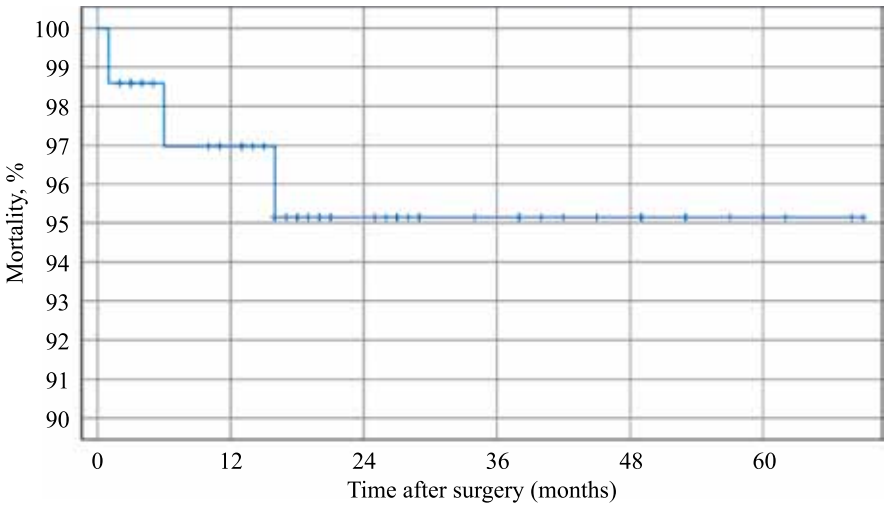

Fig. 9. Recipient survival

Immunological factor

An important factor influencing the development of complications, restoration of graft function and postoperative complications is the number of haplotype mismatches. There was an average of 4.5 ± 0.9 HLA mismatches.

The group of patients with 3 or more HLA matches (n = 12) had a higher percentage of primary function compared to the group with 2 or less HLA matches (n = 59) (58.33% and 42.37% respectively), as well as a better 3-year survival (100% and 85.9%, respectively).

There was a direct correlation between the number of HLA matches and graft survival. In patients with 3 or more HLA matches, graft survival was 100%, whereas in the group with 2 or less HLA matches, it was 85.9%.

Technological factor

Prior to March 2014, there were no kidney transplant surgeries performed in Krasnoyarsk Krai. We noted that the highest number of complications in the early postoperative period was observed in patients who underwent CKAT in 2014–2016. A decrease in the number of complications is associated with mastering and improving donor conditioning methods, organ explantation and CKAT technology, and accumulation of experience by medical and nursing personnel. At KRCH, CKAT is no longer a unique operation, but a routine one.

Twenty percent of patients had early postoperative complications after CKAT in 2014–2016, whereas in 2017–2019 it was only 13.04%. The need for early postoperative graftectomy was 8% in 2014–2016 and 4.34% in 2017–2019.

Graftectomies were performed in 9 (12.67%) patients. The main reasons leading to graftectomy in our observation were vascular thrombosis (4.22%).

So, primary function was observed in 32 (45.08%) patients, while delayed function in 39 (54.92%). One-year graft survival after CKAT was 87.3%. The main reasons leading to graftectomy in our observation were vascular thrombosis (4.22%), acute humoral (2.81%) and chronic steroid-resistant rejection (1.4%). The possibility of postponed acute cellular graft rejection having an influence on occurrence of strictures and ureteral obliteration in the late postoperative period cannot be ruled out. In 2 (2.81%) patients out of 4 (5.63%) who had cellular rejection, ureteral strictures of various lengths developed in the late post-transplantation period. Sepsis was the most formidable complication in the group of transplanted patients. It led to death in 1 (1.4%) patient from the group of patients. The overall patient survival was 95.77% (68 patients).

Timely prevention and elimination of early and late complications of kidney transplantation predetermines the further functionality and survival of the donor organ. In this regard, it is necessary to monitor the recipient's condition and organ function both at the inpatient and at the outpatient treatment stages.

CONCLUSION

In Krasnoyarsk Krai today, there is a high demand for donor services and kidney transplantation. The number of effective donors and kidney transplants in KRCH is increasing every year, and fewer complications are being recorded.

Kidney transplantation is the treatment of choice for end-stage chronic kidney disease. Our data shows that 87.33% of transplants were effective. However, 32.39% of patients had postoperative complications, including immunological (9.85%), infectious (8.45%), urological (7.04%), vascular (5.63%), surgical (2.81%), oncological (2.81%) and other (4.22%) complications. The vast majority of complications were reversible and were corrected conservatively or surgically. Nevertheless, 12.67% of patients had graft loss.

The factors described above play a significant role in the success of transplantation. A personalized approach to recipients helps to reduce postoperative complications and prevent nephrotoxicity and rejection reactions.

The authors declare no conflict of interest.

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