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Brief communication

Kidney transplantation in children in the Republic of Kazakhstan

Sholpan Altynova [1], Saltanat Rakhimzhanova [2], Samat Issakov [3], Ardak Ainakulov [4], Gani Kuttymuratov [5], Aigerim Abdiorazova [6], Gulnur Daniyarova [7], Saule Shaisultanova [8], Aliya Sailybayeva [9], Yuriy Pya [10]

[1] *Director of Medical and Regulatory affairs Department, University Medical Center, Astana, Kazakhstan. E-mail: Venera.Altynova@umc.org.kz*

[2] *Head of the Nephrology and Dialysis Program, University Medical Center, Astana, Kazakhstan. E-mail: Saltanat.Rahimzhanova@umc.org.kz*

[3] *Dialysis doctor – nephrologist, University Medical Center, Astana, Kazakhstan. E-mail: isakov.samat@umc.org.kz*

[4] *Head of the Urology department, University Medical Center, Astana, Kazakhstan. E-mail: ardak.ainakulov@umc.org.kz*

[5] *Transplantologist, University Medical Center, Astana, Kazakhstan. E-mail: gani.kt@umc.org.kz*

[6] *Deputy Chairman of the Board, University Medical Center, Astana, Kazakhstan. E-mail: a.aigerim@umc.org.kz*

[7] *Academic secretary, University Medical Center, Astana, Kazakhstan. E-mail: daniyarova.g@umc.org.kz*

[8] *General Manager of Medical and Regulatory affairs Department, University Medical Center, Astana, Kazakhstan. E-mail: shaisultanova.s@umc.org.kz*

[9] *Director of the Department of Science, University Medical Center, Astana, Kazakhstan. E-mail: s.aliya@umc.org.kz*

[10] *Chairman of the Board of the University Medical Center, Astana, Kazakhstan. E-mail: yuriy.pya@umc.org.kz*

Abstract

The purpose of the research is to analyze the clinical experience of kidney transplantation in children with end-stage chronic renal failure carried out since the inception of the comprehensive program at the National Scientific Center for Maternal and Child Health. The indicated specific goals of the study are to assess the survival rate of patients, analyze the causes of the unsuccessful kidney transplantation and address the question of peculiarities of kidney transplantation for children.

Methods. This study is designed as a retrospective cohort study. Data were retrospectively reviewed from medical records to assess the effectiveness and outcomes of kidney transplantation in this population.

Results. Mortality is significantly lower, and the quality of life is substantially higher in children with end - stage chronic renal failure who have undergone kidney transplantation compared to those receiving hemodialysis or peritoneal dialysis. Transplant loss and mortality occurred in 17 (13.4%) and 7 (5.9%) cases, respectively.

Conclusion. The data reveal notable success in transplant survival, particularly from living donors, with one - year, five - year, and ten-year survival rates of 92%, 79%, and 76%, respectively.

Keywords: end-stage chronic renal failure, renal replacement therapy, survival rate, Transplant loss, peritoneal dialysis

Corresponding author: Gulnur Daniyarova, Academic secretary, University Medical Center, Astana, Kazakhstan
Postal code: Z05K4F4
Address: Kazakhstan, Astana, Kerey and Zhanibek Khans St. 5/1
Phone:+77055965060
E-mail: daniyarova.g@umc.org.kz

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Introduction

End-stage chronic renal failure (ESCRF) in children represents the final stage of chronic kidney disease (CKD), which inevitably leads to a fatal outcome if untreated. It is universally recognized that the optimal renal replacement therapy (RRT) for children with ESCRF is kidney transplantation. On October 26, 1954, Joseph Murray performed the first successful kidney transplantation on an adult patient from his brother. The first successful kidney transplantation in a child was performed by L. Michan in 1953 from mother to child [1,2].

In 1965, Academician B.V. Petrovsky performed the first successful kidney transplantation from mother to son suffering from end-stage chronic renal failure in the USSR. In recent years, kidney transplantation in children has become quite common, with patient survival rates of 90% or more and graft survival rates of approximately 85% at one year. The high efficacy of preemptive transplantation – performed before the initiation of dialysis therapy – is proven.

The mortality rate among children who have undergone kidney transplantation is significantly lower. The demand for organ transplants exceeds existing rates by several orders of magnitude. The primary barrier to wider adoption of this method is the shortage of donor organs, which necessitates the development of new donor and consultative programs in all regions. However, due to the presence of a paired donor organ, finding a kidney donor is easier than finding a donor for heart transplantation. A healthy person needs only one kidney to perform essential functions like filtering blood, maintaining chemical and water balance, and regulating blood pressure. It is much more effective to transplant a kidney from a living person without compromising their health than to wait for a cadaveric organ [3].

Theoretically, a kidney should be transplanted to a child from another child. In Russia, for more than 20 years, the determination of brain death in children has not been legislated, and there is a presumption of parental refusal after brain death. Therefore, a kidney is typically transplanted to a child from an adult donor. Transplanting a kidney to its anatomically correct location is impossible due to the large size of an adult kidney; however, the kidney fits well in the child's abdomen [4].

Previously, children weighing less than 20 kg and shorter than 1 meter were not operated on. In the West, adult kidneys have been transplanted to very young children for forty years. For children under 5 years old, transplantation from a relative is practically the only option because it is much harder for a small child to endure the postoperative period with delayed graft function, which is more common with cadaveric kidney transplantation.

To wait for transplantation, a child with chronic renal failure needs continuous blood purification. It is impossible to live indefinitely on dialysis therapy. Children experience worsening heart failure, high blood pressure, bone deformities, and an increased risk of hepatitis. These children grow poorly, making it nearly impossible to reach the required 20 kg. Therefore, as soon as a child turns 1-1.5 years old, parents should consider transplantation. Transplantation should not be refused even if the child weighs no more than 7 kg.

Global experience shows that cadaveric kidneys are not suitable for very young children – they are initially heavily damaged and cannot function adequately and quickly after transplantation. Kidneys with immediate function often go through a polyuric phase of renal failure, where the transplanted cadaveric kidney excretes urine at a very high rate: about a liter per hour [4,5]. This polyuric phase can last from several hours to several days, posing a significant risk of dehydration and chemical imbalance, potentially leading to death in a child.

Unfortunately, no country in the world can provide all potential recipients with cadaveric donor organs. This problem has led to the increased use of living related donor transplants; however, it is not fully resolved today. The use of transplants from living related donors is primarily due to better outcomes, as the genetic proximity of the recipient and donor and the good condition of the graft contribute to this. Since November 19, 2012, a comprehensive Kidney Transplantation Program for children has been implemented at the "University Medical Center" Corporate Fund.

The purpose of the research is to analyze the clinical experience of kidney transplantation in children with ESCRF carried out since the inception of the comprehensive program at the National Scientific Center for Maternal and Child Health (NSCMCH). The indicated specific goals of the study are to assess the survival rate of patients, analyze the causes of the unsuccessful kidney transplantation and address the question of peculiarities of kidney transplantation for children.

Materials and Methods

This study is designed as a retrospective cohort study. Data were retrospectively reviewed from medical records to assess the effectiveness and outcomes of kidney transplantation in this population. This study was conducted in strict accordance with the principles outlined in the Helsinki Declaration. Prior to the commencement, approval from the University Medical Center local ethics committee was obtained.

A total of 144 kidney transplants were performed in children aged 3 to 18 years from November 19, 2012, to November 19, 2023, including 41% girls and 59% boys. The average age of the children was 13 years and 4 months, with the youngest recipient being 2 years old and the minimum weight being 8 kg. The primary kidney diseases leading to ESRF are presented in Table 1. Eighty-five children (59%) started RRT with peritoneal dialysis (PD), 29 (17.4%) with hemodialysis (HD), and 31 children (21.2%) underwent pre-dialysis kidney transplantation.

Kidney transplantation from living related donors was performed in 75% of cases (average donor age was 37.5 years) and presented in Table 2.

Table 1 - Primary kidney diseases leading to ESRF in children

Primary kidney diseases leading to ESRF	Distribution
congenital anomalies of the kidneys and urinary tract	42.6%
glomerular diseases	35.6%
cystic kidney diseases	21.8%

In 85% of cases, the kidney was harvested laparoscopically. In 25% of cases, kidneys were transplanted from deceased donors (average age of the deceased donor was 39.5 years).

For children weighing 8-15 kg:

The donor kidney was transplanted through a midline laparotomic approach and placed in the right iliac fossa of the abdominal cavity. The vascular anastomosis was formed between the renal artery and aorta, and the veins with the inferior vena cava, respectively.

Table 2 - Kidney transplantation from living related donors

Donors of kidney	Distribution
Mothers	46%
Fathers	31%
other relatives (uncle, brother, sister, etc.)	23%

For children weighing more than 15 kg:

An extraperitoneal hockey-stick approach was used to create a bed in the iliac fossa for the donor kidney. The vascular anastomosis was formed "end-to-side" with the common iliac vessels.

On July 8, 2022, the first successful paired kidney exchange was conducted in the Republic of Kazakhstan among ABO incompatible pairs (parents and children) – cross transplantation as illustrated in Figure 1. This is one of the techniques used in the shortage of donor organs.

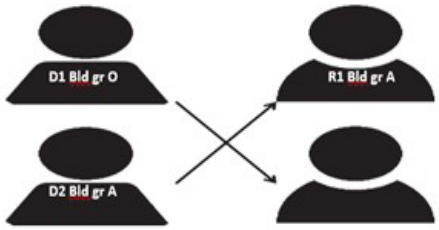


Figure 1 - Cross transplantation

Results

Mortality is significantly lower, and the quality of life is substantially higher in children with ESCRF who have undergone kidney transplantation compared to those receiving hemodialysis (HD) or peritoneal dialysis (PD) as shown in Table 3.

Table 3 - Survival rates of kidney transplants in NSCMCH patients from 2012-2023

Years	Overall Survival	Survival of Transplant from Living Donor	Survival of Transplant from Deceased Donor
1-year	92%	94%	85%
5-year	79%	88%	52%
10-year	76%	88%	

Transplant loss and mortality occurred in 17 (13.4%) and 7 (5.9%) cases, respectively. Causes are summarized in Table 4.

Discussion

Kidney transplantation is the preferred treatment method for end-stage renal failure in children, providing better survival rates, skeletal growth, health-related quality of life, and neuropsychological development compared to dialysis. Successful transplantation leads to accelerated growth and weight gain, overcoming the physical development delay often observed in children during illness. Quality of life indicators are much higher in children with normal transplant function than in those on dialysis. Advances in pediatric transplantation are associated with the development of pharmacology, improved

surgical techniques, better donor organ selection, and enhanced early detection and treatment of transplant rejection.

Transplantation consists of two stages. The donor kidney is extracted first, followed by its implantation into the recipient child's abdominal cavity. The transplant operation takes 6-8 hours; with the time the kidney remains outside the human body not exceeding one hour. Recovery after kidney transplantation is rapid. Almost all kidneys from living related donors begin to produce urine immediately after being connected to the recipient's blood flow, with diuresis amounting to several liters within the first 24 hours' post-surgery. Donors start walking by evening, and children within a week. Children with a transplanted kidney grow, attend school, marry, and have children. The only requirement is the lifelong intake of immunosuppressive drugs. The lifespan of a transplanted kidney is limited. A repeat transplantation will be needed in 20-25 years. The average lifespan of a cadaveric graft is about 6-7 years and does not exceed 10 years. The high quality of transplants from related donors allows successful transplantation of kidneys from adult donors to children of any age. In children, the survival rate for related transplants under 5 years is 62%, from 6-10 years is 75%, and from 11-15 years is 73% [5]. The three-year survival rate is 52%, 65%, and 59%, respectively.

Table 4 - Causes of unsuccessful transplantation

Causes of unsuccessful transplantation		Number of cases
Transplant loss (13.4%)	primary non-functioning transplant	4
	disease recurrence	2
	drug rejection	6
	vascular thrombosis	3
	chronic nephropathy	2
Mortality (5.9%)	cardiovascular diseases	3
	infections	1
	pulmonary edema	1
	bowel obstruction	1

The peculiarities of the children's immune system require very cautious administration of immunosuppressive therapy in the postoperative period [6]. These circumstances, as well as the characteristics of certain diseases unique to childhood and often recurring, compel physicians to be particularly meticulous in managing the patient from the first hours after the operation and throughout the entire subsequent rehabilitation period.

Factors contributing to improved kidney transplantation outcomes in children include better preparation of patients for surgery, the use of modern anesthesiology, improved surgical techniques, and new immunosuppressive drugs [2].

Evaluating the experience of 144 kidney transplants, we consider the efforts made to implement this program successful. The findings of this retrospective cohort study demonstrate that kidney transplantation significantly improves survival and quality of life in children with end-stage renal failure compared to dialysis. The one-year, five-year, and ten-year transplant survival rates were 92%, 79%, and 76%, respectively, with higher success rates observed in transplants from living donors. Despite the overall success, challenges remain, including transplant loss due to non-functioning transplants, disease recurrence, and complications such as infections and cardiovascular issues. Enhancing donor organ availability and early detection of graft dysfunction are critical to further improving outcomes in pediatric kidney transplantation. As a result, several issues require further resolution, including:

- Increasing the proportion of cadaveric donor kidney transplants and legally substantiating the post-mortem donation system for children with ESRF in need of kidney transplants.
- The shortage of donor organs kills thousands of patients annually. The foundation for effective transplantation assistance to the population is the efficient organization of organ donation and the creation of a transplant coordination system.
- Transplant coordination should ensure vertical and horizontal links between all regions in terms of maintaining a register of potential donors, transferring organs between subjects, etc.
- The introduction of advanced methods for early diagnosis of transplant dysfunction/rejection.
- Improving transplant survival rates.

Conclusion

This retrospective cohort study underscores the efficacy of kidney transplantation as the optimal treatment for children with end-stage renal failure, significantly enhancing survival rates and quality of life compared to dialysis. The data reveal notable success in transplant survival, particularly from living donors, with one-year, five-year, and ten-year survival rates of 92%, 79%, and 76%, respectively. However, the study also highlights ongoing challenges, including transplant loss, disease recurrence, and post-transplant complications. The critical shortage of donor organs remains a significant barrier, emphasizing the need for improved organ donation programs and legislative support for post-mortem donations. Future efforts

should focus on advancing early diagnostic methods for graft dysfunction and rejection, and developing robust transplant coordination systems. Continued innovation and strategic planning are essential to address these challenges and enhance the overall outcomes of pediatric kidney transplantation.

Conflict of interests: Authors declare no conflict of interest.

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Қазақстан Республикасындағы балаларға бүйрек трансплантациясы

Алтынова Ш.Х. [1], Рахымжанова С.С. [2], Исаков С.Е. [3], Айнакулов А.Д. [4], Құттымұратов Ғ.М.[5], Әбдиоразова А.А. [6], Даниярова Г.Д. [7], Шайсултанова С.Т.[8], Сайлыбаева А.И. [9], Пя Ю.В. [10]

[1] Медициналық және реттеуші мәселелер департаментінің директоры, University Medical Center, Астана, Қазақстан. E-mail: Venera.Altynova@umc.org.kz

[2] Нефрология және диализ бағдарламасының меңгерушісі, University Medical Center, Астана, Қазақстан. E-mail: Saltanat.Rahimzhanova@umc.org.kz

[3] Диализ дәрігері-нефролог, University Medical Center, Астана, Қазақстан. E-mail: isakov.samat@umc.org.kz

[4] Урология бөлімшесінің меңгерушісі, University Medical Center, Астана, Қазақстан. E-mail: ardak.ainakulov@umc.org.kz

[5] Трансплантолог дәрігер, University Medical Center, Астана, Қазақстан. E-mail: gani.kt@umc.org.kz

[6] University Medical Center корпоративтік қоры Басқарма төрағасының орынбасары, Астана, Қазақстан. E-mail: a.aigerim@umc.org.kz

[7] Ғылыми хатшы, University Medical Center, Астана, Қазақстан. E-mail: daniyarova.g@umc.org.kz

[8] Медициналық және реттеуші мәселелер департаментінің бас менеджері, University Medical Center, Астана, Қазақстан. E-mail: shaisultanova.s@umc.org.kz

[9] Ғылым департаментінің директоры, University Medical Center, Астана, Қазақстан. E-mail: s.aliya@umc.org.kz

[10] University Medical Center Басқарма төрағасы, Астана, Қазақстан. E-mail: yuriy.pya@umc.org.kz

Түйіндеме

Зерттеудің мақсаты: Ұлттық ғылыми ана мен бала орталығында (Астана қаласы) кешенді бағдарлама құрылған сәттен бастап жүзеге асырылатын созылмалы бүйрек жеткіліксіздігінің соңғы сатысы бар балалардағы бүйрек трансплантациясының клиникалық тәжірибесін талдау. Зерттеудің нақты мақсаттары: науқастардың өмір сапасын бағалау, сәтсіз бүйрек трансплантациясының себептерін талдау және балаларға бүйрек трансплантациясының ерекшеліктері туралы мәселені шешу болып табылады.

Әдістері. Бұл зерттеу ретроспективті когорттық зерттеу болып табылады. Деректер осы популяциядағы бүйрек трансплантациясының тиімділігі мен нәтижелерін бағалау үшін медициналық жазбалардан ретроспективті түрде қаралды.

Нәтижелер. Гемодиализ немесе перитонеальді диализ алған балалармен салыстырғанда бүйрек трансплантациясы бар созылмалы бүйрек жеткіліксіздігінің соңғы сатысы бар балаларда өлім-жітім айтарлықтай төмен және өмір сапасы айтарлықтай жоғары. Трансплантацияның түсуі және өлім көрсеткіші сәйкесінше 17 (13,4%) және 7 (5,9%) жағдайда болды.

Қорытынды. Деректер трансплантацияның, әсіресе тірі донорлардың өмір сүруінде айтарлықтай табысқа қол жеткізгенін көрсетеді: жылдық, бес жылдық және он жылдық өмір сүру деңгейі сәйкесінше 92%, 79% және 76% құрайды.

Түйін сөздер: созылмалы бүйрек жеткіліксіздігінің соңғы сатысы, бүйректі алмастыру терапиясы, өмір сүру деңгейі, трансплантаттың жоғалуы, перитонеальді диализ.

Трансплантация почки детям в Республике Казахстан

Алтынова Ш.Х. [1], Рахымжанова С.С. [2], Исаков С.Е. [3], Айнакулов А.Д. [4], Куттымуратов Г.М.[5], Абдиоразова А.А. [6], Даниярова Г.Д. [7], Шайсултанова С.Т.[8], Сайлыбаева А.И. [9], Пя Ю.В. [10]

[1] *Директор департамента по медицинским и регуляторным вопросам, University Medical Center, Астана, Казахстан. E-mail: Venera.Altynova@umc.org.kz*

[2] *Заведующий программой "Нефрологии и диализа", University Medical Center, Астана, Казахстан. E-mail: Saltanat.Rahimzhanova@umc.org.kz*

[3] *Врач диализа – нефролог, University Medical Center, Астана, Казахстан. E-mail: isakov.samat@umc.org.kz*

[4] *Заведующий отделением урологии, University Medical Center, Астана, Казахстан. E-mail: ardak.ainakulov@umc.org.kz*

[5] *Врач трансплантолог, University Medical Center, Астана, Казахстан. E-mail: gani.kt@umc.org.kz*

[6] *Заместитель Председателя Правления, University Medical Center, Астана, Казахстан. E-mail: a.aigerim@umc.org.kz*

[7] *Ученый секретарь, University Medical Center, Астана, Казахстан, E-mail: daniyarova.g@umc.org.kz*

[8] *Генеральный менеджер департамента по медицинским и регуляторным вопросам, University Medical Center, Астана, Казахстан. E-mail: : shaisultanova.s@umc.org.kz*

[9] *Директор департамента науки, University Medical Center, Астана, Казахстан. E-mail: s.aliya@umc.org.kz*

[10] *Председатель правления, University Medical Center, Астана, Казахстан. E-mail: yuriy.pya@umc.org.kz*

Резюме

Цель исследования: проанализировать клинический опыт трансплантации почки у детей с терминальной стадией хронической почечной недостаточности, осуществляемый с момента создания комплексной программы в Национальном научном центр здоровья матери и ребенка (Астана). Конкретные цели исследования: оценить выживаемость пациентов, проанализировать причины неудачной трансплантации почки и решить вопрос об особенностях трансплантации почки детям.

Методы. Данное исследование является ретроспективное когортное исследование. Данные были ретроспективно рассмотрены из медицинских записей для оценки эффективности и результатов трансплантации почки в этой группе населения.

Результаты. Смертность значительно ниже, а качество жизни существенно выше у детей с терминальной стадией хронической почечной недостаточности, перенесших трансплантацию почки, по сравнению с детьми, получающими гемодиализ или перитонеальный диализ. Потеря трансплантата и смертность произошли в 17 (13,4%) и 7 (5,9%) случаях соответственно.

Выводы. Данные показывают заметный успех в выживаемости трансплантатов, особенно от живых доноров: годовая, пятилетняя и десятилетняя выживаемость составляет 92%, 79% и 76% соответственно.

Ключевые слова: терминальная стадия хронической почечной недостаточности, заместительная почечная терапия, выживаемость, потеря трансплантата, перитонеальный диализ.