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Transplantation of 2-Month-Old En Bloc Pediatric Kidneys After a Complex Vascular Reconstruction – Traveling 2500 Miles to Get Transplanted: A Case Report

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Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Conflict of interest: None declared

Patient: Male, 30-year-old
Final Diagnosis: End stage renal disease secondary to hypertensive nephropathy
Symptoms: Uremic symptoms
Medication: —
Clinical Procedure: —
Specialty: Transplantology

Objective: Rare disease

Background: En bloc pediatric kidneys (EBPK) are one potential solution to increase the number of organs available in the donor community, thus promoting transplantation of these allografts into adult recipients. However, EBPK transplantation has been traditionally considered suboptimal due to concerns for perioperative complications, mainly vascular thrombosis. We report an en bloc kidney transplantation using vascular grafts from another deceased donor to extend the EBPK aorta and vena cava and create a tension-free anastomosis with recipient external iliac vessels.

Case Report: A pair of 2-month-old female en bloc kidneys weighting 6 kg were transplanted to a 30-year-old adult male. Prolonged cold ischemic time (CIT) was related to high refusal rate and long travel from Nevada to Miami. Prior to transplantation, the EBPK were connected to the LifePort Renal Preservation Machine® and deemed transplantable only after showing a significant improvement in perfusion parameters. Back-table reconstruction was conducted through an end-to-end anastomosis between an adult deceased donor common iliac artery and vein grafts to the inferior vena cava and aortic distal ends, respectively. The patient displayed immediate graft function (IGF) without any postoperative complications, showing a creatinine of 1.5 mg/dl at 4-month follow-up.

Conclusions: Use of renal preservation machine (RPM) and refined back-table reconstruction of these allografts are important tools to improve the significant discard rate and improve outcomes of EBPK.

Keywords: Kidney Transplantation • Pediatrics • Reconstructive Surgical Procedures • Vascular Grafting

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Background

Renal transplantation remains the best treatment option for patients with end-stage kidney disease (ESKD). However, only a small proportion of these patients finally receive a kidney transplant due to an important mismatch between potential candidates and donor organ availability [1].

En bloc pediatric kidneys (EBPK) transplantation is one potential solution to expand the donor kidney allograft pool [2]. Traditionally, there has been reluctance among surgeons in transplanting small pediatric organs (ie, donor age less than 3 years, weight less than 10 kg, and kidney measures less than 6 cm) due to an increased risk of postoperative vascular and urologic complications leading to delayed graft function (DGF), primary non-function (PNF), and graft loss, making their use challenging in both pediatric and adult recipients [3].

However, EBPK have been shown to provide long-term renal outcomes similar to adult single kidneys, although there remains a paucity of data regarding the smallest donors weighing <10 kg [3-5].

Furthermore, these allografts have been frequently reported to be damaged during the procurement procedure, adding even more concerns about their utilization [6]. Nevertheless, a meticulous technique of reconstruction at the back table has been previously highlighted as the key to overcome these issues [6].

We report an EBPK transplantation from an infant donor to an adult recipient after complex back-table reconstruction with arterial and venous allografts from another blood-compatible adult deceased donor. Despite the prolonged cold ischemia time secondary to the long travel from Nevada to Miami, the EBKP showed immediate graft function (IGF).

Case Report

The donor was a 2-month-old female infant who weighted 6 kg and was declared brain dead due to hypoxic brain injury (terminal creatinine level and urine output were 0.15 mg/dL and 8 cc/h, respectively).

During the en bloc kidneys retrieval, the aorta and inferior vena cava (IVC) were divided cranially at the level of the take-offs of both renal arteries and veins. The aortic and caval distal ends were divided at 4 and 3.5 cm in caudal direction, respectively. Both kidneys measured 5×2.5×1.5 cm, making the vascular ends and lower poles of the allograft located practically at the same distance from the renal hilum (**Figure 1**).

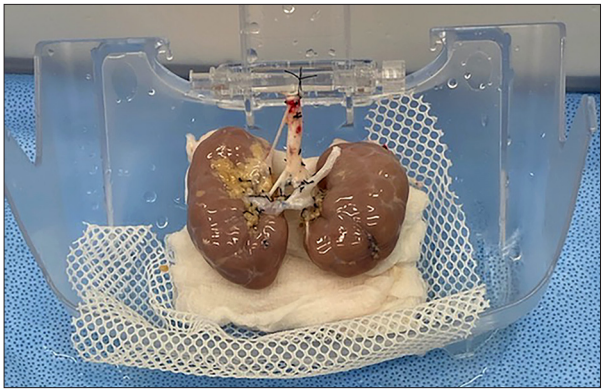

Figure 1. The 2-month-old en bloc kidneys before placement in the renal preservation machine.

Since a direct closure of both proximal vascular ends would compromise adequate graft hemodynamics, same-donor cap-shaped patches were used to close each of the proximal ends with 7-0 Prolene® running sutures [7]. At this point, the allograft was connected to the LifePort® renal preservation machine and stored in hypothermia (2-4°C) using kidney perfusion solution (KPS-1®) (**Figure 1**).

The recipient was a 30-year-old male, weight 68 kg, who had been on hemodialysis for 16 months due to hypertensive nephropathy.

The transplant was performed using the standard extra-peritoneal approach with the right iliac fossa as the site for implantation of the en bloc kidneys. After dissecting free the recipient external iliac vessels, the EBPK allograft were removed from the pulsatile perfusion machine and kept on ice. There were notable discrepancies between the aortic and IVC lengths, size of the kidneys, and depth of the location for both external iliac vessels, thus preventing a proper tension-free anastomotic outcome. Therefore, we opted to use common iliac arterial and venous graft conduits from another blood-compatible deceased donor to increase the length of the distal vascular ends. The common iliac artery and vein were anastomosed end-to-end with running 6-0 Prolene® sutures to the IVC and aortic distal ends, respectively (**Figures 2, 3**). The vascular extensions allowed the end-to-side anastomoses to the recipient right external iliac vessels in a tension-free manner using running 6-0 Prolene® sutures (**Figures 3, 4**).

Ureteroplasty was accomplished by side-to-side anastomosis of both distal ureters with 6-0 PDS running suture, and stent-free extravesical ureteroneocystostomy was performed onto the recipient bladder dome using 6-0 PDS running suture, in line with the Miami Transplant Institute (MTI) technique [8] (**Figure 3**).

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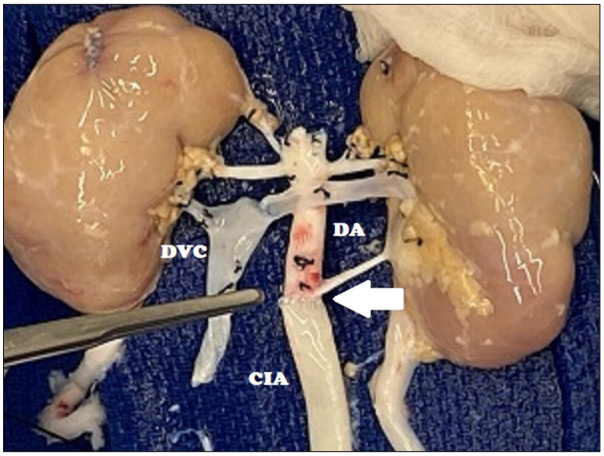

Figure 2. Back-table vascular reconstruction of the 2-month-old en bloc kidneys with end-to-end anastomosis between donor aorta and common iliac arterial graft (white arrow). DVC – donor vena cava; DA – donor aorta; CIA – common iliac artery graft.

The cold and warm ischemia times were 1973 and 24 minutes, respectively. No surgical drainage was used.

The recipient received immunosuppressive therapy according to protocols adopted at our institute, with induction consisting of intravenous antithymocyte globulin (1 mg/kg×3 doses), methylprednisolone (500 mg×3 doses) and basiliximab (20 mg×2 doses) [9]. The first dose of each immunosuppressant drug was administered intraoperatively before reperfusion of the renal allograft. Maintenance immunosuppression included a steroid-free regimen consisting of tacrolimus and mycophenolate mofetil, starting on postoperative day 1.

Postoperative Doppler ultrasound showed no collections in the perinephric space or signs of obstructive uropathy. Laminar blood flow and normal parameters (ie, resistive index, peak systolic velocity and ratio, and Z-velocity) in both the external iliac and graft arteries were also recorded.

The patient had an uneventful recovery, showing a Cr level of 1.5 mg/dl at 4 months.

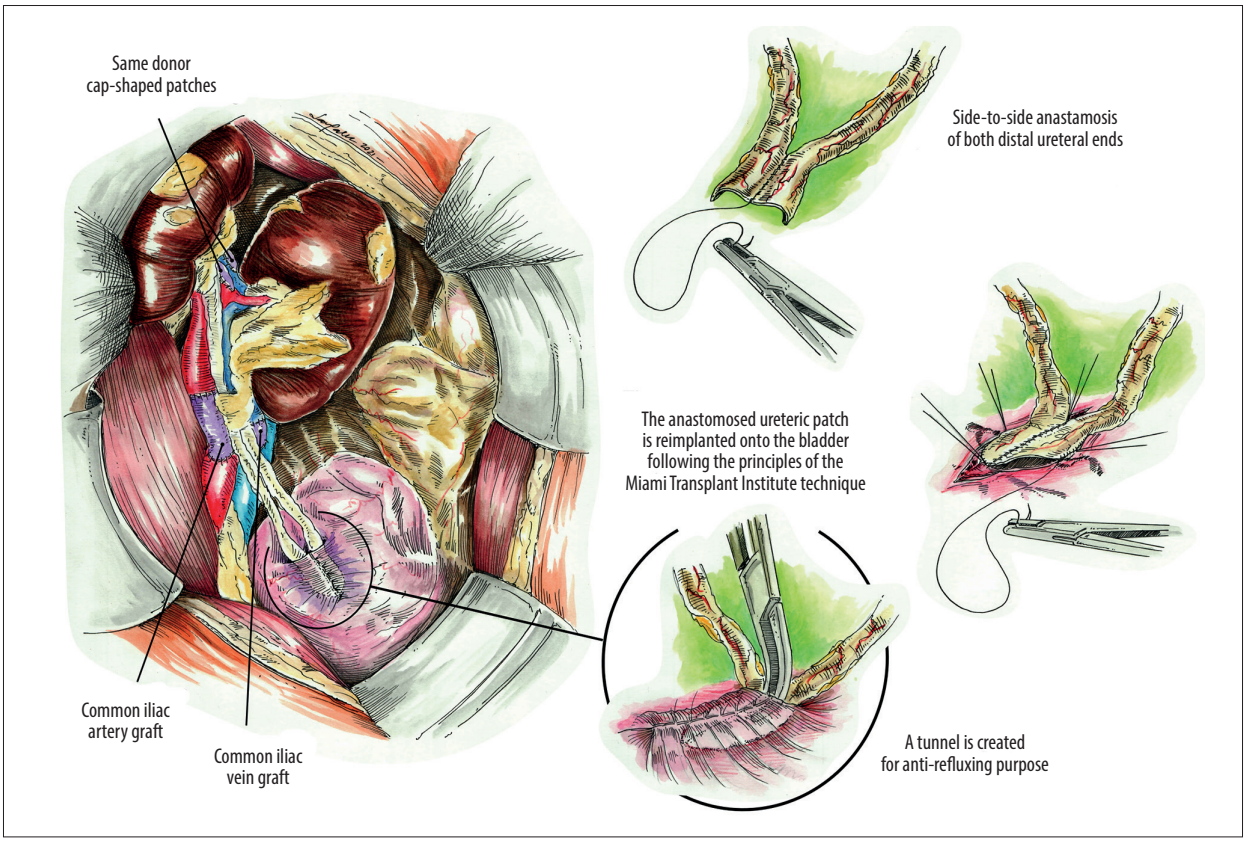

Figure 3. Visual of the arterial anastomosis, venous anastomosis, ureteral preparation, and anastomosis according to the Miami Transplant Institute technique.

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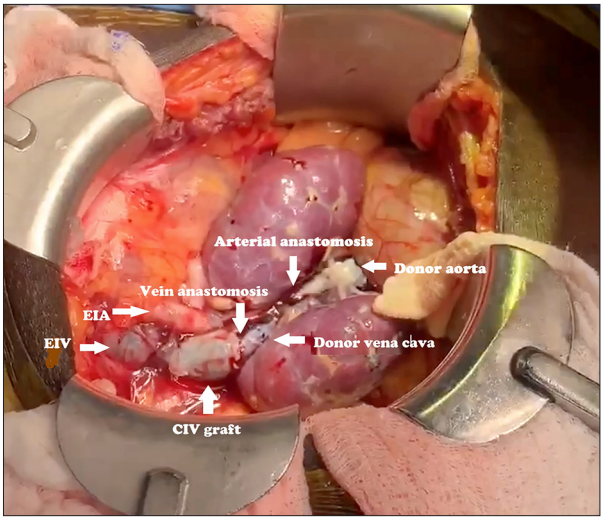

Figure 4. Intraoperative image of the reperfusion of the 2-month-old en bloc kidneys: end-to-end anastomosis between donor aorta and common iliac arterial graft and between donor vena cava and common iliac venous graft are shown. CIV – common iliac vein graft; EIA – recipient external iliac artery; EIV – recipient external iliac vein.

Discussion

The disparity between potential recipients on the waiting list and availability of organs continues to grow. Aiming to resolve this issue, Meakins et al were the first authors to describe successful transplantation of en bloc pediatric kidneys into adult recipients. Nevertheless, most transplant centers refrain from using renal allografts of pediatric donors younger than 2 years old due to concerns such as risk of dysplasia, development of hyper-filtration injury, insufficient nephron mass [11-13], and increased occurrence of vascular [14,15] and urologic complications [12].

In particular, vascular thrombosis is the most common surgical complication in this group of EBPK and is the leading cause of graft loss, with a reported incidence of 10-25% [16,17], which is much higher than the rate among adult donors (3.3%) [18]. Indeed, older age is generally considered to be negatively correlated with the incidence of vascular complications [19].

All these points suggest a high discard rate of pediatric kidneys [12,13], meaning that the use of pediatric transplants has not been optimized.

Nevertheless, follow-up of pediatric transplant patients, both single and en bloc, showed similar outcomes and renal function as adult donors [20,21], with a reported 1- and 5-year death censored graft survival of 91% for donation after brain death (DBD) grafts and of 89% and 87%, respectively, for donation after cardiac death (DCD) grafts [3].

In addition, pediatric grafts provide adequate renal function almost immediately after transplant, despite their small size, and appear to grow and mature rapidly to resemble adult kidneys within the first years after transplant [22].

The length of the donor aorta and vena cava may not always match the depth of recipient external iliac vessels, causing excessive traction and reduced mobility with limited placement of the graft and increased risk of vascular thrombosis [11]. This discrepancy is more important when using en bloc kidneys from infant donors. Therefore, aiming to avoid vascular complications secondary to excessive traction at the anastomotic sites, in our patient, cap-shaped same-donor grafts were placed in both proximal ends of the allograft aorta and IVC [23], and 2 conduits were placed at the distal allograft vascular ends, thus permitting their elongation. The reconstruction using vascular elongation patches and conduits has proved to be a useful and safe method for decreasing the incidence of vascular-related complications in transplantation [7,24].

Although there are few reports of back-table EBPK reconstruction and transplantation with good graft function previously published [7,25-27], all these reports agree on the crucial role of using a meticulous technique during the vascular reconstruction [7,25-27], which, in the light of the results obtained in this case, we also recognize as essential.

This EBPK procured in Las Vegas (NV) already had a prolonged cold ischemia time of 25 hours by the time it arrived at our institute in Miami, (FL) confirming the significant non-acceptance rate for pediatric kidneys, particularly for grafts from newborn and infant donors [12,13].

When the kidneys arrived at our institute, they were connected to the LifePort® renal preservation machine (RPM) and stored in hypothermia (2-4°C) using kidney perfusion solution (KPS-1®). The perfusion pressure was set at 30-40/14-31 mmHg. Once placed on the RPM, the flow and resistance improved from 17 ml/min and 0.71 mmHg/ml/min to 53 ml/min and 0.31 mmHg/ml/min, respectively.

The RPM is a feasible option to determine organ viability and to evaluate marginal EBPK before transplantation. En bloc kidneys with renal flow lower than 50 ml/min and renal resistance higher than 0.5 mm Hg/ml/min should be used cautiously because of higher risk of graft loss [28].

Conclusions

The concerns regarding technical difficulty and expertise requirements in EBPK transplantation are justified in the light of previous experiences. Though these allografts do not represent

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a large part of the donor pool, we should make sure to utilize organs from every suitable donor.

Although the EBPK transplantation reported here required a complex vascular reconstruction and presented a prolonged cold ischemia time secondary to the long travel from Las Vegas to Miami, it showed immediate graft function and no postoperative complications were reported, reinforcing the concept that a delicate and refined back-table technique using deceased donor vascular grafts and the availability of machine perfusion could be crucial to avoid mishaps in the postoperative period and improve outcomes of these allografts.

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Conflicts of Interest

None.

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