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Kidney Transplantation in Children with Thrombosed Inferior Caval Vein – Atypical Vascular Anastomoses

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Background: Diffuse thrombosis of iliac veins and IVC has been considered a significant technical obstacle in pediatric kidney transplantation (KT).

Material/Methods: Between 1984 and 2018, 951 KTs were performed in our institution. In 4 children qualified for KT, diffuse thrombosis of iliac veins or IVC was found. The surgical techniques, complications, patient and graft survival, and long-term renal function were studied retrospectively. The patients' age at transplantation was 2.5–13 years and body mass was 11–39 kg.

Results: All children were transplanted with venous anastomoses made to infrahepatic IVC (3 patients) or collateral circulation (1 patient). Early complications developed in 2 patients: significant bleeding from the graft area requiring revision on the second day after transplantation and chyle leak that resolved spontaneously. The follow-up period was 1–12.5 years. Three patients are alive with a follow-up at 7 months, 4.5, and 12 years with serum creatinine 0.7 mg%, 0.6 mg% and 1.4 mg%, respectively. One patient died 1 year after KT, with normal graft function. No late complications related to KT were observed in any patient.

Conclusions: Renal transplantation in pediatric patients with thrombotic vascular complications is associated with a number of technical difficulties and problems.

MeSH Keywords: Kidney Transplantation • Renal Insufficiency • Venous Thrombosis

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Background

One of the possible complications recognized in patients with chronic renal failure is the lack of vascular access due to massive venous thrombosis. These problems may be related to previous surgical interventions in patients with terminal kidney failure, including renal transplantation, graftectomy, and hemodialysis using permanent or temporary central venous high-caliber catheters or peripheral venous arterial fistula. These procedures can lead to various vascular complications resulting in extensive venous thrombosis. Diffuse thrombosis of iliac veins and inferior vena cava (IVC) have been considered significant technical obstacles in pediatric kidney transplantation (KT). Therefore, it is necessary to look for other options to provide sufficient venous drainage of the kidney. To create a proper outflow from the kidney, various options can be used, including venous anastomosis to the infrahepatic part of IVC, the mesenteric veins, gonadal and portal vein [1]. Atypical intra-abdominal locations of a renal graft associated with vascular thrombosis may force variant arterial anastomoses and urinary drainage. The aim of the study was to present the experience of our transplant center in kidney transplantations performed in children with major systemic venous thromboses.

Material and Methods

Between 1984 and 2018, 951 kidney transplantations were performed in pediatric patients in our center. In 4 children (0.42%), diffuse thrombosis of both iliac veins and IVC was found at the time of qualification for transplantation. The patients' age at KT ranged from 2.5 to 13 years (mean, 6 years), including 1 girl and 3 boys, with body mass ranging from 11 to 39 kg (mean, 21 kg). All recipients were qualified for KT from deceased donors only. Since renal transplantation in this group of patients is a high-risk operation, living related donors were disqualified from donation. The patients were qualified for KT with back-up recipients in case of technical problems in creating a graft venous outflow. The donors group consisted of 1 adult and 3 children, ages 9–21 years (mean, 15 years) and body weight between 30 and 70 kg (mean, 49 kg). Indications for KT were renal dysplasia in 3 patients and polycystic kidney disease (PKD) in 1 patient. Diffuse thrombosis of IVC, as well as bilateral common and external iliac veins, were found in Doppler ultrasound examination and computed tomography (CT) angiography during qualification for transplantation (Figure 1).

The present analysis was performed based on the medical records of pediatric patients with thrombosed IVC who underwent KT in our center. Surgical technique with particular emphasis on the renal vein anastomosis was evaluated. We collected the following data regarding transplantation: cold ischemia time of renal graft (CIT), early and late postoperative complications, graft and patient survival, and long-term kidney function.

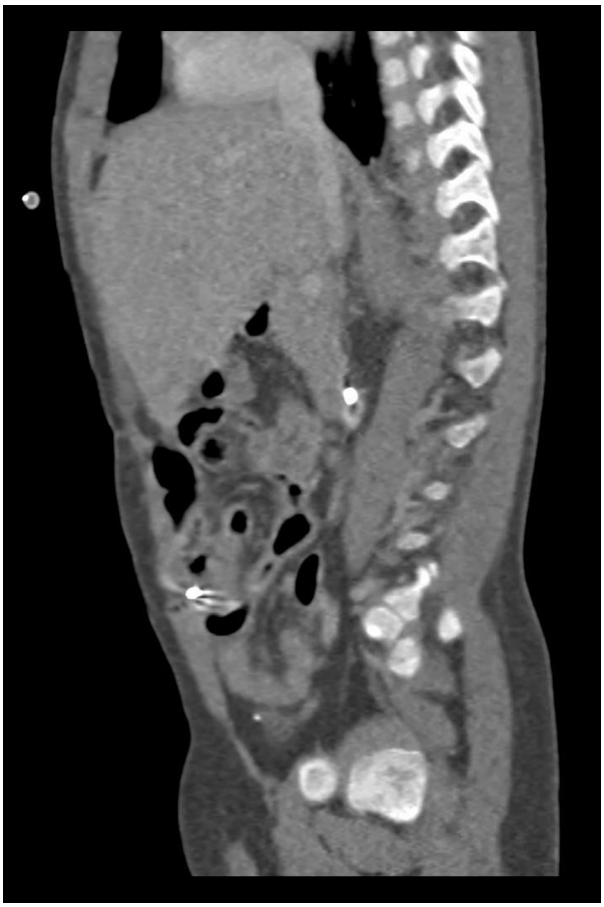

Figure 1. CT scan in patient with IVC thrombosis – lack of IVC below the liver.

Results

All transplants were made with intra-peritoneal access using the right side of the abdomen. Patent IVC was found in 3 patients just below its retrohepatic part. Venous anastomoses were made in infrahepatic IVC in 3 patients (end-to-side in 1 patient, end-to-end in 2 patients). In 1 child, anastomosis of the renal vein was performed to collateral perivertebral circulation (end-to-side) (Table 1). In all 4 children, arterial anastomoses were made to the aorta. The urinary tract was reconstructed using extravesical (Lich-Gregoire) ureterocystostomy in 3 patients. In 1 patient, right nephrectomy was simultaneously performed with uretero-ureteric anastomosis. CIT ranged from 10 to 13 h (mean, 11.6 h). The graphic descriptions of the kidney transplantation and type of venous drainage in patients with IVC thrombosis are shown in the Figures 2–4.

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Table 1. Patient characteristics and methods of venous anastomosis.

Recipients age (years)	Gender	Cause of renal disease	Donors age (years)	Venous outflow	Follow-up (years)
6	M	Renal dysplasia	21	Infrahepatic IVC	12
13	M	Renal dysplasia	13	Collateral paravertebral circulation	Death 1 year after KT
9	F	Renal dysplasia	16	Infrahepatic IVC	4.5
2.5	M	Polycystic kidney disease	9	Infrahepatic IVC	0.5

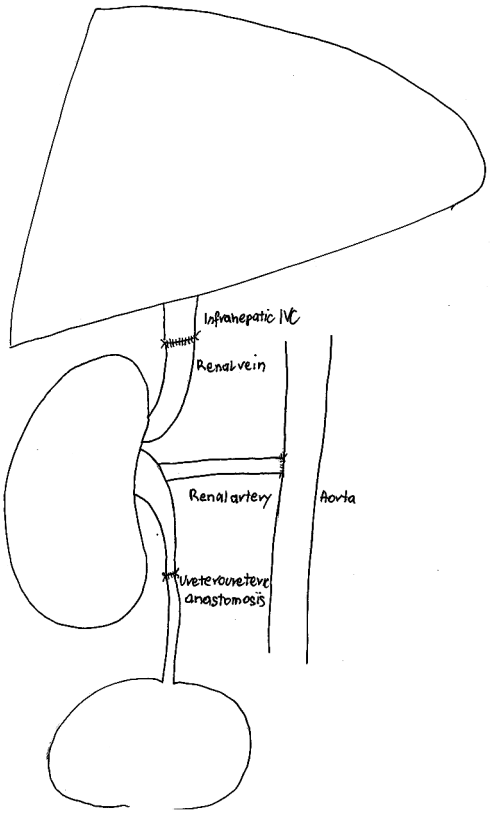

Figure 2. Venous anastomosis to the infrahepatic IVC – end-to-end.

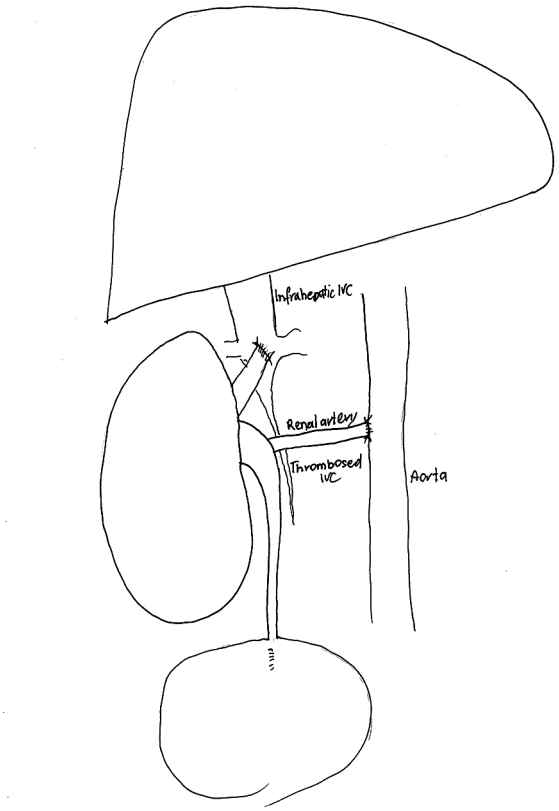

Figure 3. Venous anastomosis to the infrahepatic IVC – end-to-side.

Early post-transplant complications developed in 2 patients: significant bleeding from the graft area requiring revision on the second day after transplantation and lymph leakage requiring drainage, which lasted 14 days and resolved spontaneously. None of the patients suffered vascular complications. Early kidney function was excellent in all children. The follow-up period was 1–12.5 years (mean, 6.2 years). Current serum creatinine concentration ranged from 0.6 to 1.4 mg% (mean 0.9 mg%). One patient died 1 year after KT, with good graft function, due to complications of non-KT related co-morbid illness (intestinal pseudo-obstruction, sclerosing peritonitis). No late complications related to KT were observed in any living patients.

Discussion

The standard technique of kidney transplantation in children includes retroperitoneal access in the right or left lower quadrant of the abdomen or, in very small recipients with a body mass under 15 kg, an intra-abdominal approach, which allows

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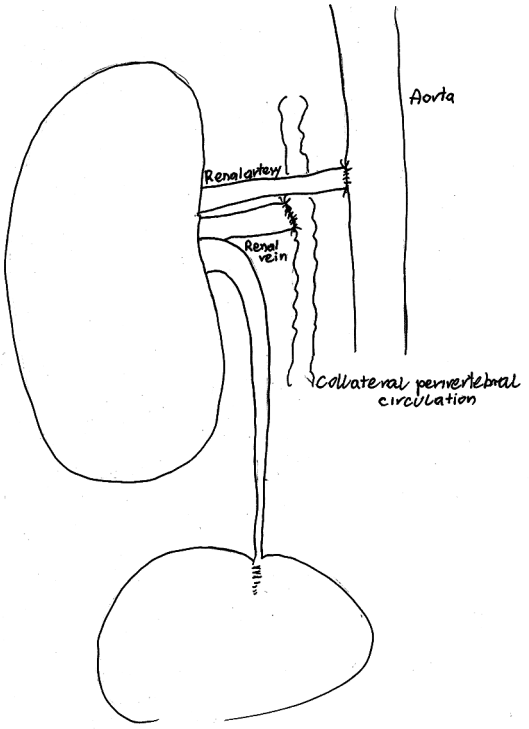

Figure 4. Venous anastomosis to the collateral paravertebral circulation end-to-side.

an ideal space for the renal implantation and decreases the risk of complications. Vascular anastomoses are usually made to external or common iliac vessels in the end-to-side fashion, but IVC or aorta just above the bifurcation may be used in case of a large discrepancy between the donor and recipient size and vessel diameters. Subsequently, the ureter is anastomosed to the bladder, usually with the antireflux mechanism.

IVC thrombosis is a rare but major complication in children qualified for KT [2]. Central venous access through a femoral vein in the past is a significant cause of IVC thrombosis in children, with an incidence rate as high as 10–15% [3]. Nephrotic syndrome (NS) clinical manifestation may include hypercoagulable states, which also raises the potential risk of thrombotic complications. The overall incidence of vascular complications in patients with the NS is about 2% [4]. Other possible causes of such a problem include the agenesis of the iliac veins and the inferior vena cava or other various congenital anomalies of the IVC [5].

The Doppler ultrasound that is routinely performed in kidney transplant candidates should provide an indication of vascular problems. Lack of patency of IVC and both iliac veins during the Doppler examination should always lead to a detailed assessment of the patient's vascular status. Computed tomography (CT) angiography and magnetic resonance (MR) angiography with 3D reconstruction are the best tools for evaluating and planning transplant surgery in these recipients [2]. All patients with diffuse thrombosis should also be screened for various types of thrombophilia before transplantation.

In patients with previous kidney transplants or vascular complications, the transplant surgeon must consider other surgical alternatives of vascular anastomosis. In the past, children with potentially compromised renal venous outflow were considered high-risk and unsuitable for kidney transplantation because of possible graft loss due to thrombosis [2]. Successful kidney transplantation requires low-pressure venous drainage to permit adequate outflow from the allograft; thus, kidney transplantation in the presence of IVC thrombosis remains a major challenge for transplant surgeons [6]. The selection of venous drainage in this situation should also include the possibility of arterial anastomosis, as well as urinary drainage. Few reports of small series or single pediatric patients with non-typical renal transplantations have been published so far [1,4,7]. The options for renal vein anastomosis include: usually patent segment of suprarenal or retrohepatic IVC, and native renal vessels following nephrectomy or presacral or paravertebral collateral vein [2,8]. Another option is the use of the portal vein system. Some authors recommend graft renal venous anastomosis to the portal system using the inferior mesenteric vein (IMV) or superior mesenteric vein (SMV) [2,7,9]. Unfortunately, the small caliber of these vessels can elevate the risk of renal vein and even portal vein thrombosis, as well as the possibility of graft rotation [10]. Tao reported successful cases of adult-to-child kidney transplantation in which the graft renal vein was anastomosed to the recipient ovarian vein in the presence of IVC and iliac vein thrombosis with no short- or long-term vascular complications [11]. Verghese, in the face of a completely thrombosed inferior vena cava, successfully performed KT in 2 small children (with an adult-sized graft) using a new technique to anastomose the renal vein to the right hepatic vein/IVC junction [12].

Although there are reports of transplantation from a living donor, in our material, all recipients were qualified for transplantation with a graft from a deceased donor. Stippel performed kidney transplantation using a living donor graft from the child's mother; the vein from the left kidney was used for anastomosis with a large presacral collateral vein [8].

In our experience, the retrohepatic and short infrahepatic segment of IVC were patent in all patients, making transplantation possible high in the right abdomen in 3 patients, and in 1 child a good size paravertebral varix was found and used for venous anastomosis. In the case of high renal vein anastomosis to the infra- or retrohepatic part of IVC, an additional problem may arise from the inadequate length of the ureter.

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If the ureter is too short to reach the bladder, the recipient's urinary tract continuity may be restored by uretero-ureterostomy if available or by the creation of an intestinal bladder [2].

Although long-term graft survival in these pediatric recipients is good unless other issues develop, renal transplantation in children with unusual vascular reconstructions is a high-risk procedure. Therefore, the recipient or guardian should be aware of the risk of complications. In extreme cases, transplantation may finally prove to be technically impossible; therefore, all such patients should be taken to surgery with a back-up recipient prepared for transplantation.

Conclusions

Renal transplantation in pediatric patients with thrombotic vascular complications is associated with a number of technical difficulties and problems. Such patients should be qualified for transplantation and operated in centers with extensive experience in vascular surgery and kidney transplantation.

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