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Abstract

A 61-year-old man received a living-donor kidney graft for an end-stage renal disease. In the postoperative course the patient was oliguric and needed dialysis. The postoperative Doppler showed a normal peak systolic velocity and maintained parenchymal perfusion associated with a *parvus tardus* signal. The patient was operated and a kinked renal artery was found. To reposition the artery, the distal iliac artery was clamped, sectioned, shortened and re-anastomosed after a 90° axial rotation. This innovative technic allowed restoration of a normal flow in the parenchyma and avoided an additional clamping, cooling, ischemia and re-anastomosis/reperfusion of the graft. Postoperative diuresis immediately raised >100 ml/h and creatinine durably returned to normal values.

Main text

Introduction

Early vascular complications after kidney transplantation represent an important cause of graft loss (1). They include hemorrhage, renal artery and vein thrombosis, arterial stenosis, venous thromboembolism, aneurysms, fistulas and recipient iliac artery complications (1). In living donors, overall vascular complication rate was estimated to be 2.8% (2). Hemorrhage is mostly caused by unligated vessels in the graft hilum/retroperitoneal space and its rate is about 1.9% (2). Renal artery thrombosis occurs in 0.4% of the cases and renal vein thrombosis in 0.1% (2). Kinking or torsion of the renal artery is an uncommon situation since most of cases are detected and corrected during the implantation phase (3). In cases that go unnoticed, the potential complications of partial kink or torsion are artery thrombosis and stenosis (1).
This paper describes the uncommon situation of a living-donor kidney graft artery kink that resulted in delayed graft function with maintained renal perfusion. The vascular problem was successfully treated by a post anastomotic external iliac artery rotation and re-anastomosis. This repair prevented additional ischemia and resulted in immediate restoration of kidney function.

Case

A 61-year-old man received a kidney graft from his healthy 56-year-old wife due to end-stage renal disease secondary to posterior urethral valves with vesicoureteral reflux. The right kidney was transplanted in the right iliac fossa by a classical distal hockey cross incision. Sequential side to end veno-venous and arterio-arterial anastomosis with 6-0 Prolene were performed after external iliac artery and vein longitudinal arterio-/venotomy according to institutional guidelines. Per institutional guidelines, no perioperative Doppler ultrasonography or medistim was performed. The graft presented no vascular anatomy abnormality. The transplant surgeon reported excellent kidney reperfusion. In-situ warm ischemia was 2 minutes (from explantation to flushing). Cold ischemia time was 1 hour and anastomotic time was 30 minutes. Reperfusion protocol biopsy showed mild to moderate acute tubular injury minimal interstitial fibrosis. Induction and maintenance immunosuppression consisted of methylprednisolone 500 mg/basiliximab 20 mg and tacrolimus 3.5 mg bid/mycophenolate mofetil 1 g bid. Standard thromboprophylaxis was administered with low dose heparin; no antiplatelet drug was received. Six hours after surgery, the patient presented oliguria despite furosemide treatment and adequate fluid management. An ultrasonography showed a kidney of normal size and echostructure, with a preserved parenchyma vascularization with arterial (hilum)
peak systolic velocity (PSV) and end diastolic velocity (EDV) of 79.3 and 32.6 cm/s
and a patent vein. PSV/EDV ratio was 2.43 and Doppler arterial curve demonstrated
a parvus tardus. Further daily ultrasonography until day 6 had similar findings while
diuresis remained <60ml/h. On day 2, a MRI with low dose gadoteric acid contrast (a
cyclic ionic chelate, i.e. 19 cc of Dotarem) described a good corticomedullary
differentiation, a thin but patent artery, a patent vein and a contrast excretion after 25
minutes. Three hemodialysis sessions were required between day 3 to day 5
because of hypervolemia and symptomatic uremia. On day 6, the diuresis was <15
ml/h and a CT-scan with iodine contrast showed a 50% narrowing of the kidney graft
artery just after the anastomosis (Figure 1, arrow; see video for full 3D
reconstruction). The patient was subsequently admitted to the operating room for a
surgical exploration. Intraoperative findings revealed a kink of the arterial
anastomosis accompanied by a macroscopically obvious kidney hypoperfusion (dark
looking kidney). To reposition the renal artery, the distal external iliac artery was
clamped (distal to renal artery anastomosis), sectioned, shortened (1 cm) and re-
anastomosed after a 90° axial rotation (figure 2). This technic avoided an additional
clamping/cooling/ischemia and re-anastomosis/reperfusion of the graft. Doing so, a
normal flow in the renal artery and parenchyma was restored as demonstrated by
immediate macroscopic pinkish recoloration of the kidney. The kidney started to
produce urine intraoperatively. Postoperative Doppler ultrasonography showed PSV
and EDV of 60.3 and 17.1 cm/s, an increase of the PSV/EDV ratio to 3.53 and the
parvus tardus had disappeared (Figure 3a, b, c). Postoperative diuresis raised >100
ml/h and kidney creatinine returned to normal values (figure 4). After two years of
follow-up, the patient is doing well and the kidney function is preserved with a
creatinine of 1.33 mg/dl (eGFR 58 mL/min/1.73m2).
Discussion

Kidney delayed graft function is a difficult situation especially in the context of a living donor. The rate of delayed graft function after living-donor kidney transplantation ranges between 2% to 5% (4-6). The causes are numerous and can originate from prolonged warm (anastomotic) or cold ischemia times, the use of a marginal donor, technical problems leading to vascular complications, recipient hypovolemia, inherited thrombophilia, hyperacute rejection, acute tubular necrosis, drug nephrotoxicity and urologic complications (leakage and obstruction) (7, 8). The postoperative detection of a technical problem can be challenging in the case of equivocal imaging studies. In this case, multiple ultrasonography studies and MRI did not clearly show the artery narrowing/kink. In this situation, a normal graft artery PSV was not sufficient to exclude an arterial anastomosis problem and only the Doppler curve assessment can provide valuable information. In the present case, the parvus tardus and decreased PSV/EDV ratio were difficult to interpret and the operators were probably misled by the preserved parenchymal perfusion. Consequently, only the day-6 CT-Scan highlighted the 50% narrowing of the artery and leaded to a justified but delayed surgical exploration. Knowing that a selective arteriography could have been a valuable alternative to the CT-Scan, this kind of procedure is far not a standard in our institution. An endovascular procedure was discussed before surgery but this option was not selected. In this situation, we assumed that an anatomical repair of the kink would provide the best short and long term chances of success. The precise understanding of the problem provided by CT-scan 3D reconstruction was essential before deciding on a new surgery. Nevertheless, the technical repair that we chose was decided peroperatively. In any case, it is worth
noting that a delayed graft function in a living-donor kidney recipient without hemodynamic compromise should lead to consider an urgent surgical exploration. Fortunately, a minimal arterial perfusion appears to have been maintained during postoperative days 0 to 6, which precluded a complete thrombosis/necrosis of the graft. This technic for repositioning the renal graft artery permitted to maintain the previous end-to-side anastomosis untouched; thus, avoiding the graft explantation and the mandatory flushing with cold preservation solution and new vascular anastomoses. Another point is that we performed the arterial anastomosis on the external iliac artery; implantation on the common iliac artery would have been an interesting alternative that could further reduce the chance of a vascular complication, as previously suggested (9).

In conclusion, this description of a living donor kidney graft artery kink successfully treated with an external iliac artery resection and re-anastomosis, demonstrates that an initial low urine output in a living-donor kidney recipient accompanied with a \textit{parvus tardus} curve on Doppler signal should lead to a prompt surgical exploration.

Legend to figures

\textbf{Figure 1}: CT-Scan with iodine contrast (arterial phase) showing a 50% narrowing/kink of the kidney graft artery just after the anastomosis (arrow). See video for full 3D reconstruction.

\textbf{Figure 2}: schematic representation of the procedure used to unkink the renal graft artery. The distal iliac artery was clamped, sectioned (one centimeter of length was removed), shortened and re-anastomosed after a 90° axial rotation.
Figure 3: Doppler ultrasound images before (a) and after (b) arterial reconstruction. Preoperative Doppler curve show a *parvus tardus* shape (arrows) that disappeared after artery repositioning (arrows). Graph showing arterial (hilum) peak systolic velocity and end diastolic velocity over time (c). Peak systolic velocity (PSV); End diastolic velocity (ESV).

Figure 4: graph representing creatinine (red line) and diuresis (blue line) during the 12 post-transplantation days.

Legend to video

Video: 3D reconstruction of the CT-Scan (arterial phase).

References:


Figure 1
Figure 2
Figure 3
Figure 3

![Graph showing changes in PSV/ESV ratio, peak systolic velocity, end diastolic velocity, and peak ratio over postoperative days.]

- **Transplantation**, **Dialysis**, and **Surgery** are indicated on the graph.
- The x-axis represents postoperative day(s) from 0 to 12.
- The y-axis represents the PSV/ESV ratio from 0 to 5.
- The graph lines indicate different parameters:
  - Green line with green triangles: Peak ratio.
  - Red line with red circles: Peak systolic velocity.
  - Blue line with blue triangles: End diastolic velocity.

The graph shows fluctuations in these parameters post-surgery, with notable peaks and troughs at specific postoperative days.
Figure 4

The graph illustrates the changes in creatinine and diuresis over the postoperative days. The y-axis represents creatinine levels in mg/dL and diuresis in ml/h, while the x-axis represents postoperative day(s).

Key events include:
- Transplantation
- Dialysis
- Surgery

The graph shows a decrease in creatinine levels following transplantation, with a subsequent rise post-surgery. Diuresis levels increase after transplantation and surgery, stabilizing over time.