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Case Report

Innovative Arterial Reconstruction with Donor Iliac Artery During Multiple Artery Kidney Transplantation

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Abstract

Due to the severe shortage of organs for transplantation, new surgical techniques have been designed for bench or in-situ reconstruction to use all compatible organs that may have been discarded for anatomical arterial variations, as is the case for Multiple Renal (MRA) grafts. [1-3] We highlight in our case the transplant of a brain-dead donor's MRA kidney, with four arteries and two veins, in a patient presenting bilateral severe atheromatous iliac arteries, using an innovative reconstruction vascular technique of the donor's iliac artery as a common stem for the four renal arteries.

Keywords: Arterial reconstruction; Chronic kidney insufficiency; Double renal vein; Kidney transplantation; Multiple renal arteries; Transplant complications; Urinary tract disease; Urinary pathology; Vascular reconstruction techniques

Introduction

Standardised surgical procedures in kidney transplants have been challenged in the last decades due to the increased use of kidney allografts previously judged unsuitable for transplantation. [3] Refinement of surgical techniques has significantly reduced the rate of surgical complications, rendering renal transplantation safe and inciting surgeons to go further to use MRA allografts. [3,4] We report our experience with an MRA kidney transplant in a patient with severe atheromatosis using an innovative vascular reconstruction technique. Written informed consent was obtained before surgery, and permission was given for publication.

Case Presentation

A 34-year-old end-stage renal disease patient with chronic tubulointerstitial nephropathy, receiving renal replacement therapy since 2001 (21 years of hemodialysis), underwent kidney transplantation derived from a 49-year-old brain-dead donor, in July 2022**.** We harvested the kidney, using the Cleveland technique with in-situ splitting, with half of the aorta (Figure 1), during a multiorgan retrieval procedure. The kidney had four arteries and two veins, an anatomical configuration with an incidence of 0,4%.

[5] The graft was cold-stored for transportation. Cold Ischemia Time (CIT) was 12 hours.

Figure 1: MRA graft before back table reconstruction.

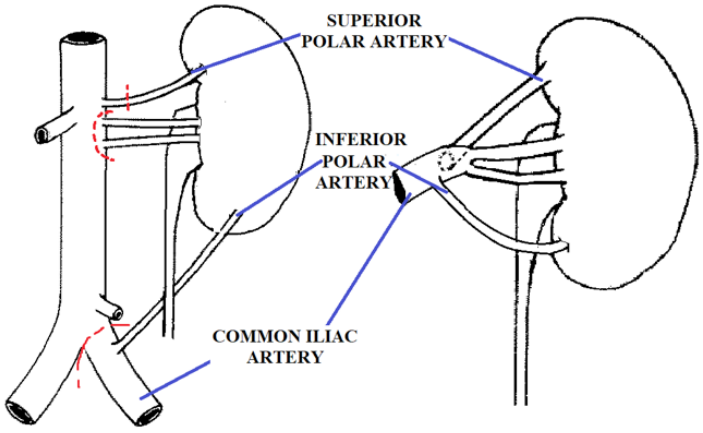

Figure 2: Scheme of the arterial vascularisation reconstruction.

Preoperative, two significant constraints arose: the graft's particular anatomical configuration; the presence of severe atherosclerosis on both the right common iliac artery and left internal iliac artery revealed by the patient's CT scan. We opted for the ex-vivo microvascular technique, creating a single arterial ostium for maximal vascular anastomosis accuracy and minimal Warm Ischemic Time (WIT). [6] The arteries were trimmed and prepared on the back table (Figure 2). Polar vascularisation was rigorously respected. Although ligation of accessory arteries is permissible in some instances (with risks of segmental ischemia), we preferred to preserve the whole arterial blood supply to avoid parenchymal necrosis. [7-10] Ligation of the inferior polar artery being formally contraindicated, since ureteral blood supply would be compromised, [6-8,11-13] we used it as base of our vascular reconstruction for its anatomical proximity to the common iliac artery's origin (Figure 1). The Superior Polar Artery (SPA) was placed posteriorly in an end-to-side anastomosis with the donor's common iliac artery graft. Side-to-side anastomosis in double barrel fashion was performed for the 2 hilar arteries of same calibre, followed by their subsequent anastomosis end-to-end to the donor's common iliac artery.

The result was four arteries arising from the donor's common iliac artery in a peri-hilar fork branching pattern (Figure 3). Microvascular suture lines were examined for watertightness by flushing perfusion fluid ex-vivo. The kidney was engrafted in the right iliac fossa using a single end-to-side anastomosis with an atheromatous free segment of the common iliac artery using Prolene 6/0 (Figure 4). The main renal vein was anastomosed end-to-side to the external iliac vein. The secondary vein was ligated. WIT was 35 minutes. Urine output was observed immediately after declamping with homogeneous vascularisation of the kidney. The urinary anastomosis was done using standard Lich-Gregoir techniques through a 6 French ureteral stent. Total operating time was 180 min. Doppler Ultrasound (US) revealed homogeneous perfusion and functional kidney (Figure 5). Follow-up was done clinically and using Color Doppler US. Neither postoperative vascular nor urological complications were encountered. The patient's evolution was marked by an episode of acute tubular necrosis resulting in a prolonged hospital stay with seven haemodialysis sessions. Two weeks later, the patient's renal function improved considerably. At discharge, blood analysis noted a WBC: 9500/mm^3, urine out-put: 4500 ml/24 hours, creatinine level: 3,17 mg/dL and a urea level: 141,24 mg/dL (eGFR=24,22 ml/min/1,73m^2), US showed a renal graft positioned in the right iliac fossa, parenchymal index (IP) =15mm, with homogeneous vascularisation and no peri-graft collection. Total hospitalisation stay was 30 days. At three months follow-up, creatinine level and blood urea were respectively 2mg/dL and 79,18mg/dL with an eGFR=42,33 ml/min/1,73m^2. Ultrasound examination showed normal Doppler parameters with a resistivity index (IR)= 0.68 and IP= 1.19.

Figure 3: Kidney graft after vascular reconstruction.

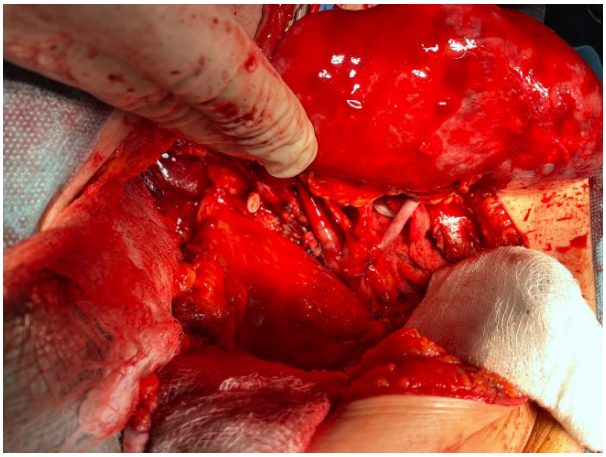

Figure 4: MRA kidney graft revascularization.

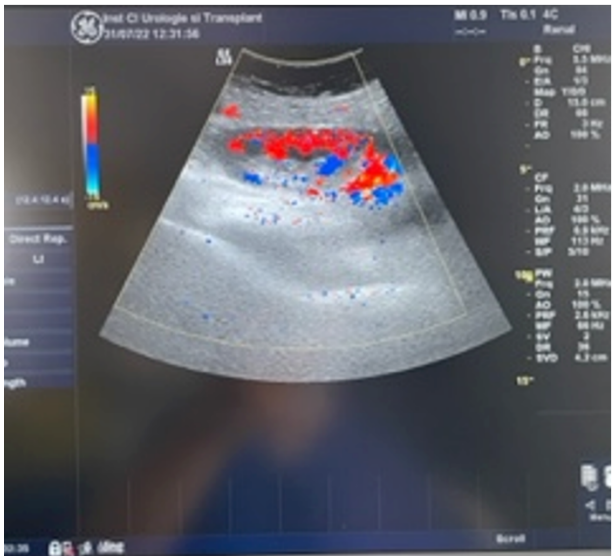

Figure 5: Postop doppler ultrasound showing an adequate flow after transplantation.

Discussion

The reported incidence of MRA in cadaveric organ procurement is 18%–30%, which gives all its importance to the understanding of the renal vascular supply and the risks incurring its modulation. [1,14,15] MRA transplantation is associated with a higher overall vascular complication rate than single renal artery (SRA) transplantation. [2,16,17] Vascular complications, including renal artery stenosis, thrombosis, post-transplant bleeding, aneurysmatic dilatation, significant kinking of the artery during graft placement and increased risk for renovascular hypertension, have multifactorial etiologies. [4,18-21] Nevertheless, they share a main causative factor: technical issues during transplant surgery. These technical issues implicated as pathogenic factors are anastomotic suturing techniques, renal artery trauma during graft nephrectomy or implantation, kinking of the renal artery, and donor or recipient arteries atherosclerosis. [2,4,22] Several anastomotic techniques have been proposed to overcome them, such as using branches of the recipient hypogastric artery, a combination of the hypogastric and external iliac artery, multiple individual end-to-side anastomoses to the external iliac artery and even the inferior epigastric artery. [7,9,23,24] Still, the Carrel aortic patch remains the standard technique in transplants from cadaver donors. [25] In our case, the challenge was a four arteries allograft and severe atherosclerosis in the recipient's iliac arteries. Nonetheless, using ex-vivo reconstruction techniques allowed us to work around that problem forming a common arterial stem for four arteries, which theoretically is hemodynamically more favourable than individual separated vessel's anastomosis. [7,26,27] Eliminating discrepancies between the diameters of the vessels with fish-mouth anastomosis of SPA to the main arterial graft, we reduced upper pole infarction risks. [10,27,28] Optimal exposure provided by ex-vivo reconstruction not only minimised technical errors involved with multiple in situ anastomoses of relatively small vessels on atherosclerotic common or external iliac arteries [7,8,26] but also avoided obstructions by the atherosclerotic plaques during the multiple anastomoses and by doing so prevented their kinking. [25] Back-table reconstruction shortening the WIT lowered the risk of kidney damage. [7] WIT is shown to be more critical to subsequent allograft dysfunction than CIT: WIT exceeding 45 minutes exacerbates the deleterious effects of cyclosporine-induced nephrotoxicity. [29,30] Prolonged CIT, following intracellular electrolyte flushing and ex-vivo reconstruction in the cold basin, increased the probability of delayed graft function and significant acute tubular necrosis after cadaver kidney transplantation, but minimising WIT remains more crucial for the graft's outcome. [8,29-31].

Conclusion

Back-table surgery reconstruction in an innovative fashion using the donor's iliac artery as the main arterial trunk is a feasible

technique which minimises vascular complications for MRA transplants. These surgeries should be planned and performed using techniques tailored to the patient's characteristics and the surgeon's professional experience.

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