Case Report

Detection of transplant renal artery stenosis with contrast-enhanced ultrasound

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ABSTRACT

Transplant renal artery stenosis (TRAS) is a vascular complication occurring during the first 2 years after kidney transplantation, with an incidence and a prevalence ranging from 1% to 23%, and from 1.5% to 4%, respectively. Detection of TRAS is the key, since most stenoses may progress to renal graft loss, however it may be difficult to detect due to its nonspecific clinical manifestations. Although Doppler ultrasound has become a primary imaging technique, digital subtraction angiography (DSA) remains the gold standard for diagnosing TRAS. We present a case of delayed graft function following kidney transplantation complicated by a lateral by-pass with prosthesis upstream and downstream of renal anastomosis, TRAS criteria were unclear using Doppler ultrasound, contrast-enhanced computed tomography-scan, and DSA. Only contrast-enhanced ultrasound (CE-US), observing a delayed and pulsating contest impregnation of renal parenchyma, supported the hypothesis of TRAS that was confirmed by the measurement of trans-anastomosis pressure gradient during DSA.

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Introduction

Successful kidney transplantation (KT) improves the quality of life and increases survival compared with long-term dialysis treatment in patients with end stage renal disease

[1]. Despite advances in KT and allografts preservation, early surgical complications are reported in up to 10% of patients, and most of them are caused by vascular pathologies such as arterial or venous thrombosis, leaks or pseudo-aneurisms,
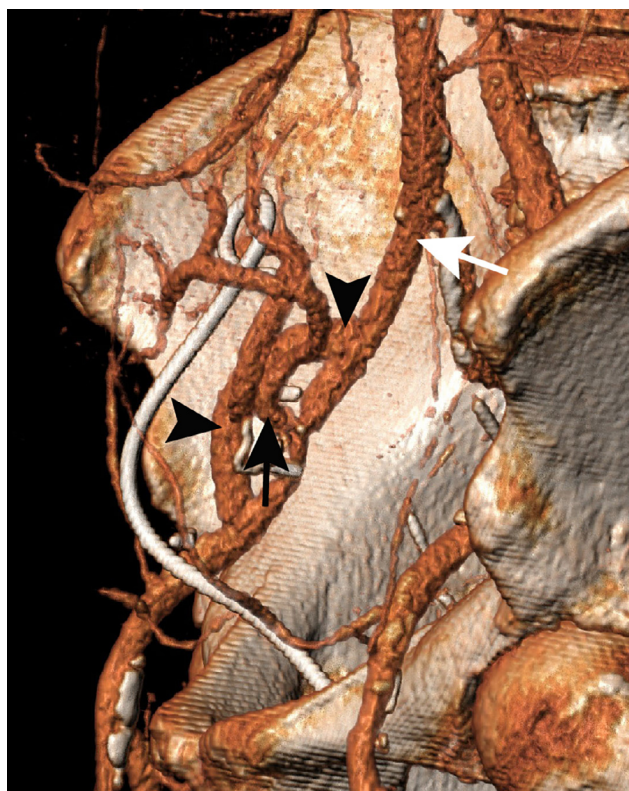
Fig. 1 – Angio-computed tomography scan volume rendering reconstruction. Renal artery (black arrow), iliac-iliac bypass (black arrowhead), external iliac artery (white arrow).

Fig. 2 – No morphological evidence of TRAS at digital subtraction angiography. Renal artery (black arrow), external iliac artery (white arrow).

and transplant renal artery stenosis (TRAS) [2]. Clinical TRAS, defined as a stenosis greater than 70%, has an angiographic incidence up to 10%. Early detection of TRAS is difficult due to nonspecific clinical manifestations but remains important to diagnose because most untreated stenoses may progress to renal graft loss [3]. Doppler ultrasound (DUS) has become the primary imaging technique in the initial screening of TRAS, but digital subtraction angiography (DSA) remains the gold standard for its diagnosis [4,5]. The recent introduction of contrast-enhanced ultrasound (CE-US) has given new perspectives for the evaluation of vascular complications after KT [6]. We present 1 case of KT in which only the use of CE-US allowed to achieve the diagnosis of TRAS (Figs. 1–3).

Case report

A 74-year-old Caucasian woman on hemodialysis secondary to diabetic nephropathy underwent KT from a deceased heart beating donor in May 2017. The patient's comorbidities included a history of severe vascular disease and hypertension, atrial fibrillation, mitral valve stenosis, and diffuse vascular atherosclerosis. The donor was a 78-year-old male receiving a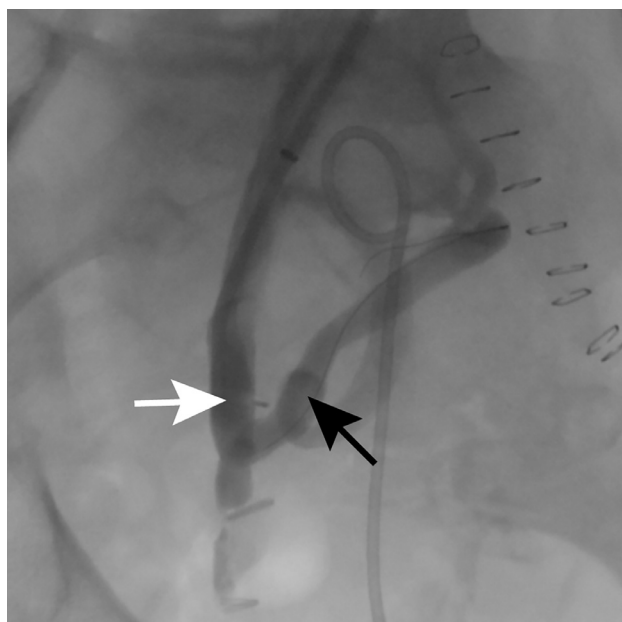ntihypertensive treatment. Karpinski score of preimplant renal biopsy was 4 (glomerulosclerosis 1, tubular atrophy 1, interstitial fibrosis 0, and arteriolosclerosis 2).

KT was performed with a right kidney positioned in the extraperitoneal right iliac fossa. Termino-lateral venous, and arterial vascular anastomoses between the kidney and the external iliac vessels were performed with a double running suture in a Prolene 6.0. After revascularization the kidney was well perfused. Few minutes later, no arterial flow was evidenced in the external iliac artery distally to the anastomosis. To avoid any damage to the kidney, the iliac artery was clamped after the anastomosis, incised longitudinally, and a wall flap, completely occluding the atherosclerotic artery lumen was evidenced. Since it was not possible to restore the flow to the leg by removing the flap, we performed a lateral by-pass with a polytetrafluoroethylene prosthesis with removable ring of 4 mm in diameter, upstream and downstream of renal anastomosis. By reducing to minimum kidney ischemia, we first performed distal anastomosis leaving renal flow, and after proximal anastomosis, clamping the iliac artery upstream the renal artery only for 5 minutes. The anastomosis was performed with a double running suture in Prolene 6.0.

After reperfusion all the vessels were patent and the graft was discreetly perfused.

In the postoperative period immunosuppressive regimen was started with mofetil mycophenolic acid, methylprednisolone, and a low dose of tacrolimus. The patient was first put on endovenous heparin followed by warfarin.

After transplantation, the kidney evidenced delayed graft function, compatible with intraoperative double ischemia reperfusion injury, characterized by high creatinine and azotemia levels (7.08 mg/dl and 78 mg/dl, respectively), low urine output (400 ml/24h), and need of hemodialysis (2 times
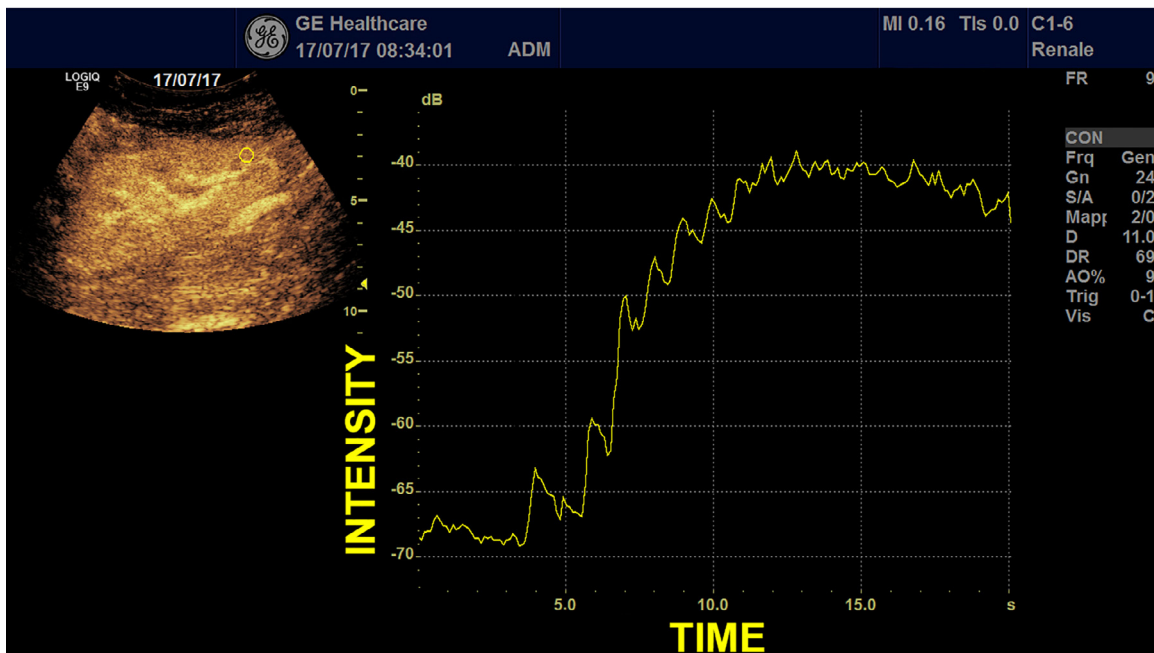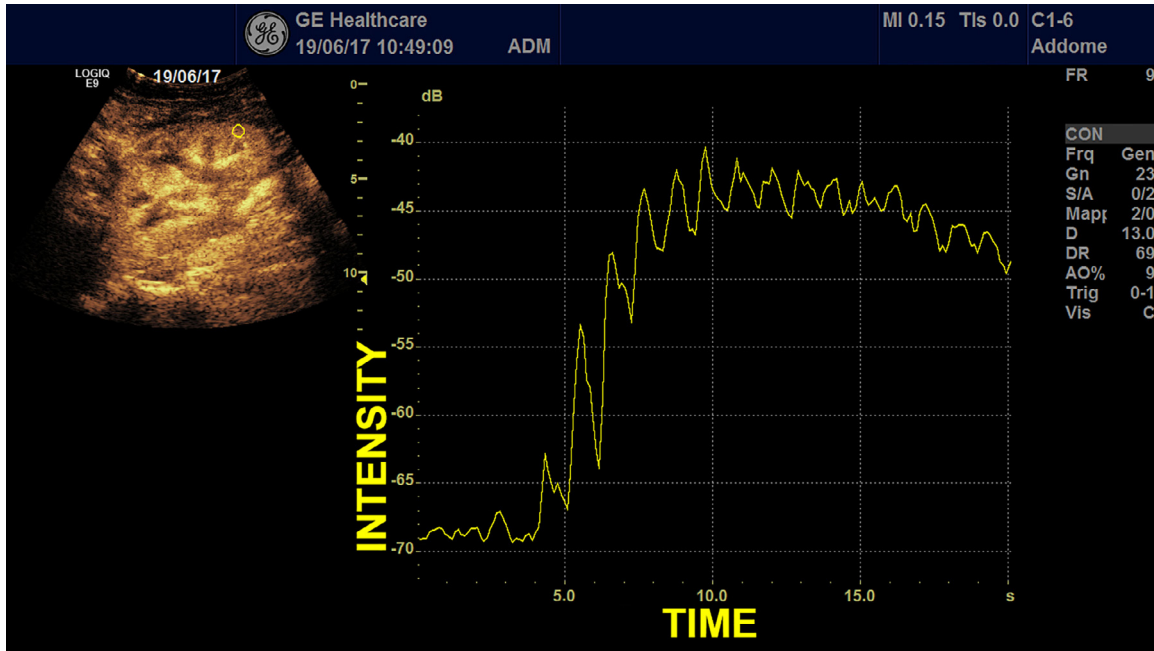
Figs. 3 and 4 – Pre and posttreatment CE-US time intensity curves (TICs). The abscissa representing the time and the ordinate intensity. Although the 2 curves show similar shapes, pretreatment TIC is more irregular, with wider difference between systolic and diastolic phases, than posttreatment TIC.

a week). During the first 2 weeks of postoperative period, despite a progressive increase in urine output until 1500 ml/die, no functional recovery of the graft was achieved, with creatinine values of 6.5 mg/dl.

Postoperative serial DUS showed intraparenchymal waveforms with rounded and low systolic peak; no diastolic flow component was found in the intrarenal arteries, thus excluding acute rejection (AR); turbulence and acceleration flow of the renal artery anastomosis were quite normal (peak systolic velocity (PSV): 150-200 cm/s). The iliac-iliac by-pass appeared patent with a regular flow. Furthermore, a subsequent CT-scan evidenced delayed nephrogenic effect, and a low contrast media filtration by transplanted kidney, confirming a regular renal artery anastomosis, and a patent by-pass. No signs of TRAS were present, supporting a possible role of a by-pass steal syndrome.

A percutaneous biopsy performed to evaluate a possible ischemic damage of the transplanted kidney showed modest

ischemic alteration at morphological and immunofluorescence analyses.

A CE-US evidenced a pulsing and delayed cortico-parenchymal impregnation, suggesting the presence of TRAS. Diagnosis of TRAS was obtained by DSA only after the measurement of trans-anastomotic pressure gradient (renal artery 153 mmHg, iliac artery 183 mmHg), since the morphological aspect was also normal. An auto-expandable stent 8 × 30 mm was inserted through the iliac by-pass and the renal artery, and postdilated to 6 mm. At the end of the procedure no transtenotic pressure gradient was noticed.

Immediately after the procedure the patient discontinued dialysis. One month later, creatinine, azotemia, and urine output were 3.27 mg/dl, 46 mg/dl, and >2500 ml/die respectively.

At 3-month follow-up, DUS showed a further reduction of turbulence and acceleration flow (PSV: 125 cm/s). CE-US evidenced a renal impregnation still slightly delayed but more uniform and gradual.

At 8-months follow-up after transplant the patient was free from dialysis, with normal diuresis ≥2000 ml/die without diuretic therapy. Creatinine levels and azotemia were ≤2.5 mg/dl and ≤50 mg/dl respectively, and the creatinine clearance was ≥20 ml/min. The patient continues antiaggregant therapy with warfarin.

Discussion

TRAS is the most frequent vascular complication after KT. Its incidence ranges from 1% to 23% with a prevalence of 1.5%-4%, and usually occurs during the first 2 years after transplantation [3]. Early detection of TRAS is important because most stenosis can be treated with surgical or radiologic intervention and, if untreated, may progress to medically refractory hypertension, deteriorating renal function, and graft loss [7,8].

Findings on CE-US examination allowed us to exclude the first hypothesis of arterial by-pass stealing syndrome and made us suspect a functional stenosis of the graft anastomosis. Doppler criteria for TRAS includes: PSV > 200 cm/s (however diagnostic PSV threshold values for TRAS in different studies ranges from 150 cm/s to 400 cm/s), a velocity gradient between stenotic and prestenotic (iliac vessel) segments of 2:1 and marked distal disturbance (spectral broadening) [9]. In the renal parenchyma, tardus-parvus waveform abnormalities can be observed but there is no agreement on a specific cut-off intrarenal resistance index value for TRAS diagnosis. In our case Doppler criteria were unclear, as were contrast-enhanced CT-scan, and the first DSA. Only CE-US, observing a delayed and pulsating contest impregnation of renal parenchyma, supported the hypothesis of TRAS, which was confirmed after the second DSA, by the measurement of trans-anastomosis pressure gradient. In our opinion, TRAS was not detected by DSA because the stenosis was not determined by a geometric stenosis, but it was a functional stenosis related to graft position. CE-US has proven to be able to detect renal perfusion changes in the early postoperative period after transplantation [10]. In fact, using contrast agent time-intensity curve we obtained a quantitative evaluation of kidney blood perfusion [11]. Parameters such as time of inflow of the contrast media into the kidney cortex, time to peak duration, peak index, curve ascending slope, and area under the curve allowed us to achieve a precise quantification of renal perfusion which correlates with renal function [12]. In literature CE-US is useful to underline different findings of parenchymal perfusion between AR, and TRAS. In the AR, rising time and time to peak of interlobar artery and medulla as well as between medulla and cortex are significantly higher compared with those in the stable group [13]. In TRAS, a longer time of contrast agent inflow compared with patients without perfusion defects are present, and a contrast agent inflow is correlated with the severity of stenosis [14].

Moreover, CE-US helped us by highlighting the vascular structures, such as the renal artery and the iliac arteries, allowing us to better identify arterial narrowing and stenosis [7,14].

Compared to computed tomography angiography and magnetic resonance angiography, CE-US has some advantages; first, ultrasound contrast agents are safe because they consist of sulphur hexafluoride gas, which is discharged via the respiratory system and not via the kidney, furthermore CE-US is a radiation-free, rapid, and economic examination and it can be performed at bed-side [15].

Conclusions

CE-US allowed a noninvasive assessment of parenchymal kidney graft perfusion. Moreover, it enabled confirmation of TRAS diagnosis in the early postoperative period after transplantation and helped to assess the degree of stenosis.

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