Case Reports

Restoration of Renal Allograft Function

via Reduced-Contrast Percutaneous Revascularization of Transplant Renal Artery Stenosis

Phillip A. Erwin, MD, PhD
Sachin S. Goel, MD
Surafel Gebreselassie, MD
Mehdi H. Shishehbor, DO, PhD

Transplant renal artery stenosis (TRAS), the most common vascular complication of kidney transplantation, can lead to heart failure, uncontrolled hypertension, and irreversible dysfunction of the transplanted kidney. Percutaneous revascularization can improve outcomes in well-selected patients with symptomatic TRAS, but the intervention itself poses risk to the transplanted kidney because of the quantities of nephrotoxic contrast solution that often are used.

We report the case of a patient with TRAS who, 5 months after undergoing a kidney transplant, developed allograft dysfunction and heart failure that required hemodialysis. We performed angioplasty and stenting of the TRAS, using intravascular ultrasonography and fluoroscopy as our primary imaging methods. To minimize further damage to a potentially viable kidney, the volume of intravascular contrast medium used was trivial (a total of 9 cc). Revascularization of the patient's TRAS restored his renal function: within 4 weeks of the procedure, he no longer needed hemodialysis, and his heart failure symptoms had resolved. This case emphasizes the value of early definitive treatment of TRAS and the usefulness of intravascular ultrasonography to minimize the amount of contrast medium used in endovascular procedures. ***(Tex Heart Inst J 2015;42(1):80-3)***

Key words: *Acute kidney injury; contrast media/adverse effects; kidney/blood supply; kidney transplantation; postoperative complications; renal artery/ultrasonography; renal artery obstruction/etiology/therapy; stents; ultrasonography, Doppler*

From: *Tomsich Department of Cardiovascular Medicine (Drs. Erwin, Goel, and Shishehbor) and Glickman Urological and Kidney Institute (Dr. Gebreselassie), Cleveland Clinic Foundation, Cleveland, Ohio 44195*

Address for reprints: *Mehdi H. Shishehbor, DO, PhD, Interventional Cardiology & Vascular Medicine, J3-5, Cleveland Clinic, 9500 Euclid Ave., Cleveland, OH 44195*

E-mail: *shishem@ccf.org*

Renal transplantation is the definitive therapy for end-stage kidney disease and provides substantial lifesaving and quality-of-life benefits for patients who would otherwise undergo dialysis.[1] Posttransplantation stenosis of the renal artery—more commonly called TRAS, or transplant renal artery stenosis—is the most frequent vascular complication of kidney transplantation.[2] It is implicated in graft dysfunction, concomitant congestive heart failure, and refractory hypertension.[3] Transplant renal artery stenosis is often detected during routine Doppler-ultrasonographic screening of the transplanted kidney or during the clinical evaluation that occurs when graft function deteriorates.[3] Percutaneous revascularization of TRAS is indicated to treat graft dysfunction; however, the conventional use of angiography to guide the intervention can put the graft at substantial risk of contrast nephropathy.[4,5] We present a case of TRAS that was discovered during the evaluation for causes of a patient's failing transplanted kidney.

Case Report

In January 2013, a 70-year-old man with end-stage polycystic kidney disease underwent cadaveric kidney transplantation. He had a history of hypertension, transient ischemic attack, and coronary artery disease. In the 4 months after his kidney transplantation, he had hospital admissions for heart failure, gastrointestinal bleeding, and acute coronary syndrome requiring percutaneous coronary intervention. The patient's serum creatinine levels increased steadily during this time, from 1.47 mg/dL at the time of transplantation to 6.99 mg/dL 5 months after transplantation. The rise in creatinine was attributed to cumulative kidney damage from intra-arterial contrast medium administered during the above-mentioned percutaneous coronary intervention, to acute tubular necrosis from hypotension, and possibly to cardiorenal syndrome. Five months after the transplantation, he presented with refractory pulmonary edema and acute-on-chronic renal failure (serum creatinine level, 6.05 mg/dL). He was treated with diuresis, which further elevated the creatinine to a peak of 7.31 mg/dL. Hemodialysis was initiated to treat azotemia and volume overload. Biopsy specimens of the transplanted kidney did not reveal any specific cause for his

worsening renal function. Doppler ultrasonography of the transplanted kidney showed severe stenosis at the proximal portion of the transplant renal artery, near the anastomosis with the external iliac artery (Fig. 1A). The peak systolic velocity at the stenosis was 810 cm/s and the end-diastolic velocity was 407 cm/s, consistent with >80% stenosis (Fig. 1B). The renal resistive indices of the upper, mid, and lower kidney poles were 0.57, 0.72, and 0.69, respectively. Given the brief duration of the patient's syndrome and the relatively normal renal resistive indices,[6] we decided to treat the TRAS with angioplasty and stenting. Our expectation was that his graft function would improve with restoration of renal artery patency.

The procedure was performed with the patient under moderate sedation and local anesthesia. After placing a 5F sheath in the left common femoral artery, we administered heparin for anticoagulation (activated coagulation time, >200 s). A 5F internal mammary artery catheter (Cordis, a Johnson & Johnson company; Bridgewater, NJ) was advanced into the right common iliac artery over an 0.035-in J-tipped guidewire (Boston Scientific Corporation; Natick, Mass). Angiography (3 cc of iopamidol-300 injectable contrast medium mixed with 4 cc of heparinized saline) showed severe stenosis (95%) in the proximal transplant renal artery and a further 80% stenosis in the mid vessel (Fig. 2A).

Because of the upward takeoff of the renal artery from the right common iliac artery, we decided to use an ipsilateral approach for revascularization. Arterial access was obtained in the right common femoral artery with use of a 6F sheath. An ASAHI® Prowater 0.014-in guidewire (Abbott Vascular, part of Abbott Laborato-

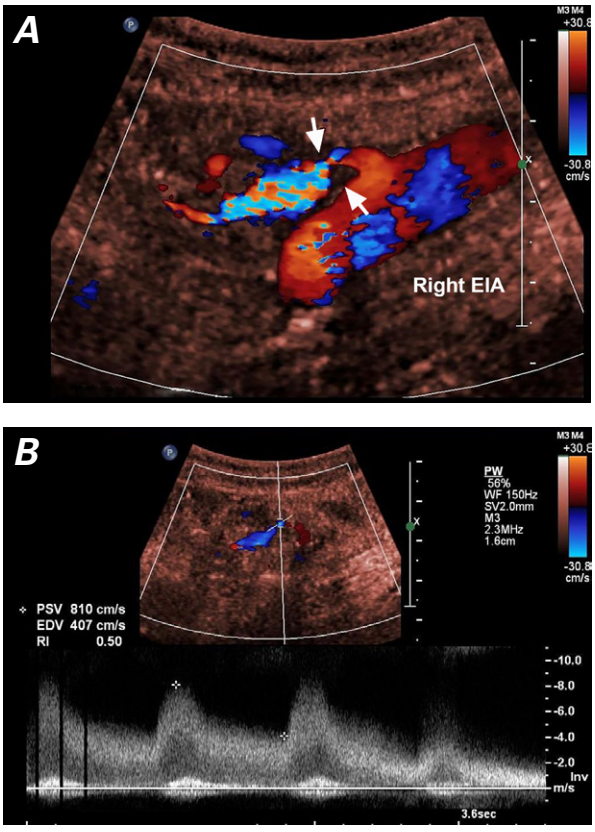


Fig. 1 *Doppler ultrasonograms of the transplant renal artery.* ***A****) Color-flow image identifies the stenosis in the proximal portion of the vessel. The arrows point to the most stenotic segment of the vessel.* ***B****) Elevated velocities and spectral broadening on pulsed-wave image confirm severe stenosis.*

EIA = external iliac artery

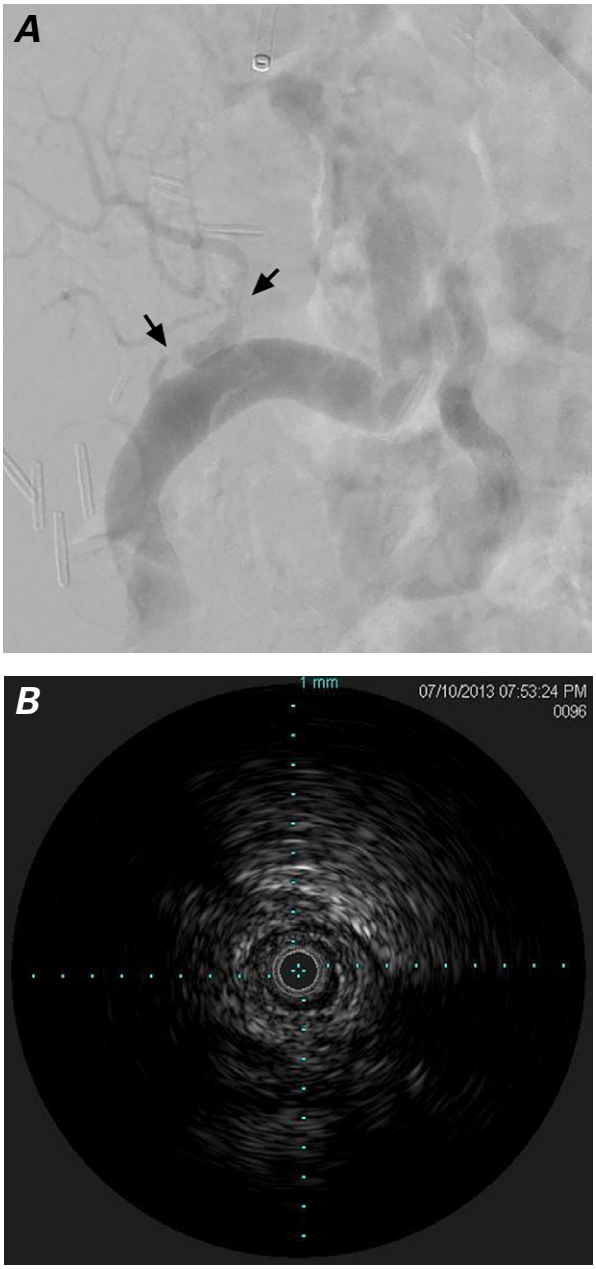
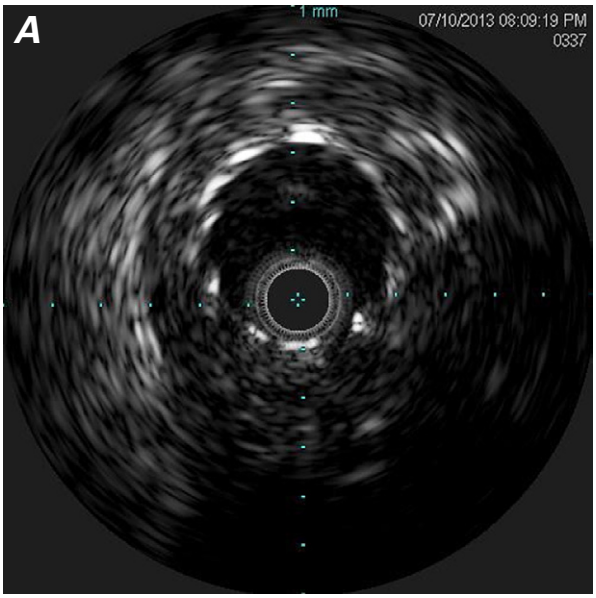


Fig. 2 ***A****) Digital subtraction angiogram shows the transplant renal artery before intervention. Arrows mark the severe stenosis of the proximal and mid segments.* ***B****) Intravascular ultrasonogram shows the stenotic segment of the transplant renal artery.*



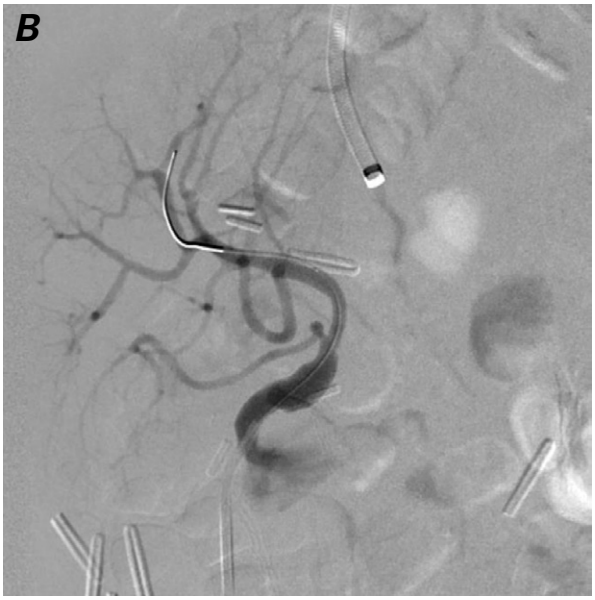


Fig. 3 ***A****) Intravascular ultrasonogram of the stented vascular segment reveals a well-expanded and well-apposed stent.* ***B****) Digital subtraction angiogram taken at the end of the procedure shows resolution of the stenosis.*

ries; Abbott Park, Ill) was advanced across the lesion in the transplant renal artery. We used bony landmarks to predilate the lesion with a 3 × 12-mm Emerge™ PTCA Dilatation Catheter (Boston Scientific) inflated to a pressure of 6 atm. Intravascular ultrasonographic (IVUS) imaging with use of an IVUS catheter (Volcano Corporation; San Diego, Calif) confirmed severe stenosis in the proximal and mid segments of the renal artery (Fig. 2B). The more distal mid renal artery lesion was dilated with a 2.5 × 15-mm Emerge balloon inflated to a pressure of 8 atm. We then used IVUS to measure the reference-vessel diameter (about 4 mm proximally) and the length of the diseased segments.

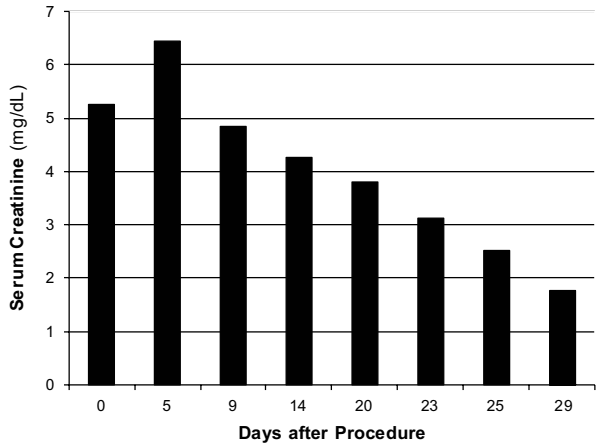


Fig. 4 *Graph shows the gradual reduction of the patient's serum creatinine values over time. The transplant renal artery was stented on day 0. Hemodialysis was discontinued on day 22.*

Using IVUS and bony landmarks as references for lesion location, we stented the proximal renal artery with a 4 × 12-mm Resolute Integrity® Zotarolimus-Eluting Coronary Stent (Medtronic, Inc.; Minneapolis, Minn), deployed at a pressure of 12 atm. Final positioning was confirmed with use of 3 cc of contrast medium mixed with 4 cc of heparinized saline. We further postdilated the stent with a high-pressure 4 × 12-mm NC Quantum Apex™ PTCA Dilatation Catheter (Boston Scientific) inflated to a pressure of 14 atm. Results of IVUS showed good stent expansion and apposition (Fig. 3A). A final angiogram was obtained with use of 3 cc of contrast medium mixed with 4 cc of heparinized saline, which showed an excellent result (Fig. 3B) without residual stenosis and with no evidence of sequelae, such as dissection or perforation. The angiogram and the intervention were successfully performed with a total of only 9 cc of contrast medium.

Within 2 weeks of the procedure, the patient reported that his urine output had increased. Dialysis was discontinued on day 22. His serum creatinine level continued to improve, from 5.25 mg/dL at the time of the procedure to 2.1 mg/dL about 4 weeks after the intervention (Fig. 4). Follow-up ultrasonography of the stented transplant renal artery 5 weeks postprocedurally showed a patent stent with peak systolic velocity of 350 cm/s and end-diastolic velocity of 30 cm/s. The serum creatinine level continued to improve over time, to 1.77 mg/dL at a 4-month follow-up visit. There were no further plans for dialysis, and the patient's dialysis access port was removed. One and a half years after the stenting procedure, the serum creatinine level was 1.6 mg/dL.

Discussion

Renal artery stenosis is the most frequent vascular complication of renal transplantation and is a well-described

cause of renal graft dysfunction that manifests itself during the first 3 months to 2 years after transplantation.[3] Its incidence is estimated at 8.3 cases per 1,000 person-years, according to one large series, but varies from 1% to 23%, depending on the definition of TRAS.[2,7] Transplant renal artery stenosis should be considered in the renal transplant patient who develops renal failure, refractory hypertension, or congestive heart failure.[3] Risk factors for TRAS are inconsistent between studies, but some proposed causes are immunemodulating drugs, advanced donor and recipient age, cadaveric donor, coronary artery disease, and technical problems with the anastomosis.[2,8] Percutaneous angioplasty and stenting is an established therapy for symptomatic TRAS and should be pursued if the prognosis of the graft after stenting is presumed to be good.[4,5] Our patient's renal resistive index was consistent with functioning parenchyma, which augured well for the graft's health[9] and, according to some authors, for a good outcome after revascularization of renal artery stenosis.[10] Nonetheless, published ultrasonographic prognostic criteria for outcomes after angioplasty of TRAS are controversial,[6] and clinical criteria to predict outcomes have yet to be determined.

The decision to pursue revascularization of TRAS is often complicated by the fact that the intervention itself places the patient's renal function at significant risk of contrast-induced nephropathy, a known poor prognostic indicator, particularly in patients with pre-existing renal insufficiency.[11] Our patient, already on hemodialysis, was at high risk of contrast-induced nephropathy and its attendant implications for morbidity and death.[11] The use of IVUS to minimize contrast use in percutaneous intervention[12] and to optimize stent placement in renal artery stenting[13] has been described; however, there are scant reports on the use of IVUS as the primary imaging method in the treatment of TRAS.

Although the use of drug-eluting stents is safe and effective in TRAS, such stents have not been shown to prevent in-stent restenosis in the renal arteries.[14] Nonetheless, we elected to use a coronary drug-eluting stent off-label, because of the known risk of in-stent restenosis in nontransplant renal arteries <4.5 mm in diameter[15] (the transplant renal artery in this patient was about 4 mm in diameter).

While the optimal approach to treating symptomatic TRAS has not been determined, this case illustrates the important role of endovascular intervention for affected patients and the usefulness of nonangiographic imaging in preventing contrast-induced nephropathy.

References

1. Tonelli M, Wiebe N, Knoll G, Bello A, Browne S, Jadhav D, et al. Systematic review: kidney transplantation compared with dialysis in clinically relevant outcomes. Am J Transplant 2011;11(10):2093-109.
2. Hurst FP, Abbott KC, Neff RT, Elster EA, Falta EM, Lentine KL, et al. Incidence, predictors and outcomes of transplant renal artery stenosis after kidney transplantation: analysis of USRDS. Am J Nephrol 2009;30(5):459-67.
3. Bruno S, Remuzzi G, Ruggenenti P. Transplant renal artery stenosis. J Am Soc Nephrol 2004;15(1):134-41.
4. Henning BF, Kuchlbauer S, Boger CA, Obed A, Farkas S, Zulke C, et al. Percutaneous transluminal angioplasty as first-line treatment of transplant renal artery stenosis. Clin Nephrol 2009;71(5):543-9.
5. Leonardou P, Gioldasi S, Pappas P. Transluminal angioplasty of transplanted renal artery stenosis: a review of the literature for its safety and efficacy. J Transplant 2011;(2011):693820.
6. Tublin ME, Bude RO, Platt JF. Review. The resistive index in renal Doppler sonography: where do we stand? AJR Am J Roentgenol 2003;180(4):885-92.
7. Fervenza FC, Lafayette RA, Alfrey EJ, Petersen J. Renal artery stenosis in kidney transplants. Am J Kidney Dis 1998;31(1):142-8.
8. Patel NH, Jindal RM, Wilkin T, Rose S, Johnson MS, Shah H, et al. Renal arterial stenosis in renal allografts: retrospective study of predisposing factors and outcome after percutaneous transluminal angioplasty. Radiology 2001;219(3):663-7.
9. Radermacher J, Mengel M, Ellis S, Stuht S, Hiss M, Schwarz A, et al. The renal arterial resistance index and renal allograft survival. N Engl J Med 2003;349(2):115-24.
10. Radermacher J, Chavan A, Bleck J, Vitzthum A, Stoess B, Gebel MJ, et al. Use of Doppler ultrasonography to predict the outcome of therapy for renal-artery stenosis. N Engl J Med 2001;344(6):410-7.
11. Mehran R, Aymong ED, Nikolsky E, Lasic Z, Iakovou I, Fahy M, et al. A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: development and initial validation. J Am Coll Cardiol 2004;44(7):1393-9.
12. Ogata N, Matsukage T, Toda E, Tamiya S, Fujii T, Nakazawa G, et al. Intravascular ultrasound-guided percutaneous coronary interventions with minimum contrast volume for prevention of the radiocontrast-induced nephropathy: report of two cases. Cardiovasc Interv Ther 2011;26(1):83-8.
13. Dangas G, Laird JR Jr, Mehran R, Lansky AJ, Mintz GS, Leon MB. Intravascular ultrasound-guided renal artery stenting. J Endovasc Ther 2001;8(3):238-47.
14. Zahringer M, Sapoval M, Pattynama PM, Rabbia C, Vignali C, Maleux G, et al. Sirolimus-eluting versus bare-metal low-profile stent for renal artery treatment (GREAT Trial): angiographic follow-up after 6 months and clinical outcome up to 2 years. J Endovasc Ther 2007;14(4):460-8.
15. Lederman RJ, Mendelsohn FO, Santos R, Phillips HR, Stack RS, Crowley JJ. Primary renal artery stenting: characteristics and outcomes after 363 procedures. Am Heart J 2001;142(2):314-23.