Renal Artery Stenosis in En-Bloc Pediatric Renal Transplant: Demonstration by Captopril-Enhanced Renal Scintigraphy

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A double-pediatric kidney transplant recipient, who developed hypertension, was found to have unilateral renal artery stenosis. The stenosis was successfully assessed by single-dose ^{99m}Tc-diethylenetriaminepentaacetic acid renal scintigraphy, confirmed by renal arteriography, and treated by percutaneous transluminal angioplasty. This case illustrates the usefulness of Captopril-enhanced renography in screening en-bloc transplant patients suspected for renal vascular hypertension.

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Renal artery stenosis (RAS) has an incidence of 3%–16% in post-transplant hypertension (*1–3*). Renal arteriography is the gold standard for the diagnosis of RAS (*4, 5*). However, a less aggressive and nephrotoxic single-dose Captopril-enhanced renography (SDCER) is widely available for the screening of renal vascular hypertension (RVH) and may precede renal arteriography in the assessment of RAS. We describe a case of en-bloc pediatric renal transplant (*6*) with unilateral RAS which was successfully detected by SDCER.

CASE REPORT

A 34-yr-old Caucasian female, with end-stage renal disease secondary to membranous glomerulonephritis, received a double-pediatric kidney transplant from an 11-mo-old child who died from subarachnoid hemorrhage on 3-2-88. The en-bloc transplantation (*6*) was performed in the right iliac fossa. The post-operative course was uneventful except for a short episode of rejection that responded well to immunosuppressive therapy. Post-transplant baseline renal scintigraphy showed good bilateral renal flow.

On 3-3-89, the patient was re-admitted for elevation of blood pressure, requiring increasing doses of antihypertensive medication without control. Technetium-99m-DTPA renal scintigraphy revealed a decrease in function and size of the right transplant consistent with a right RAS. The following selective arteriography showed a 67% stenosis of the origin of the right transplant artery. A percutaneous transluminal angioplasty (PTA) was performed, reducing the stenosis from 67% to less than 20%. The patient was discharged with good control of her blood pressure.

On 9-8-89, another admission was necessary for uncontrolled hypertension. Physical examination found a bruit in the right iliac fossa. Pre-Captopril renal scintigraphy and SDCER (Fig. 1) suggested a recurrent right RAS. A selective renal arteriography (Fig. 2) confirmed RAS and a PTA was again successfully performed.

METHODS

Under our RAS assessment protocol, a patient who is suspected of RVH undergoes two ^{99m}Tc-DTPA renal scintigraphies on two consecutive days. A baseline renogram without Captopril is obtained on the first day. On the following morning, SDCER is performed 1 hr after oral intake of 25 mg of Captopril. Antihypertensive medication is discontinued 24 hr before SDCER. The radiopharmaceutical dose for each renal scintigraphy is 15 mCi of intravenous ^{99m}Tc-DTPA.

Both studies are performed using a large field of view gamma camera equipped with a general-purpose collimator. The gamma camera (GE 500) is interfaced with a G.E. Starcam computer. Data are acquired in frame mode with a matrix format of 64 × 64. The vascular phase is obtained 2 sec per frame for the first 60 sec. The renal phase is imaged during the next 20 min with a frame rate of 1/min. The patient is in the supine position and renal transplants are evaluated in the anterior projection of the right iliac fossa. Split renal function by the Gates' technique (*7*) (Fig. 3) is used for the evaluation of each kidney glomerular filtration rate (GFR). This split renal evaluation is a relative estimation of kidney function and serves as reference for future GFR comparison.

RESULTS

The pre-Captopril vascular phase showed early activity in both kidneys concomitant to the visualization of the aorta. This feature suggested an adequate perfusion in both sides. The right transplant was, however, much smaller than its counterpart. The renographic curve (Fig. 1A) demonstrated a normal left function with a time-to-peak activity less than 5 min. Due to its position over the urinary bladder, the left excretory curve had an ascending pattern corresponding to the bladder filling. The right renographic

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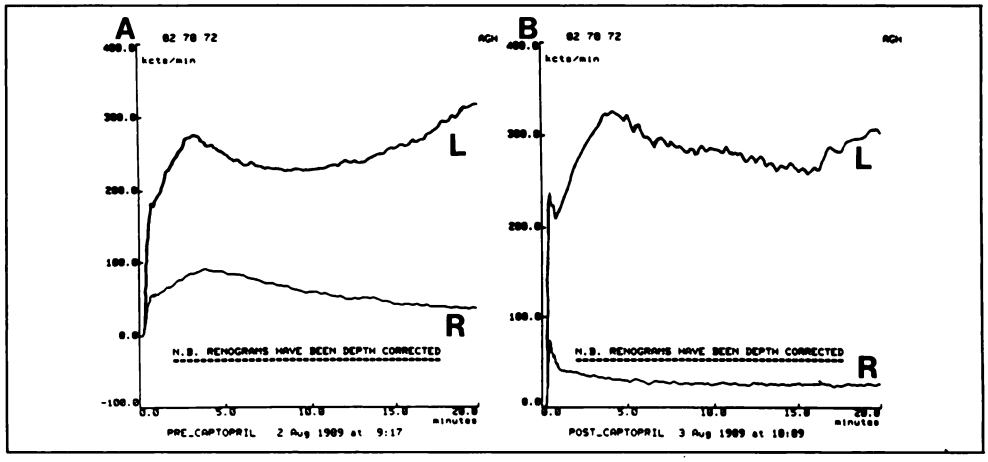

FIGURE 1. (A) Processed renogram curves of the pre-Captopril renal scintigraphy show better flow and function of the left transplant over its right counterpart. The ascending pattern of the left excretory curve is due to partial positioning of the left kidney over the urinary bladder. (B) Single-dose Captopril-enhanced renography shows significant deterioration of flow and function of the right transplant. There is no deleterious effect of Captopril on the left kidney. (R) right kidney and (L) left kidney.

curve showed flatter ascending and descending slopes, with, nevertheless, a time-to-peak activity compatible with relatively active filtration and excretion. The total estimated GFR was 137 ml/min, with right and left transplants accounting for 31.7 ml/min and 105.5 ml/min, respectively.

The post-Captopril study (Fig. 1B) had an unchanged vascular phase with equivalent flow to both kidneys. However, there was a striking modification of the right renogram curve. While the left curve remained the same, the right curve presented an absolutely flat pattern, suggesting poor uptake and excretion of radiotracer. The total estimated GFR was 118.89 ml/min, with an unaffected left value of 105.5 ml/min and a collapsed right GFR of 13.38 ml/min.

The pre- and post-Captopril studies clearly demonstrated Captopril influence on filtration and function of the transplant involved in RAS and RVH.

DISCUSSION

Post-renal transplant hypertension, with an incidence of 30%–36% (*3*), is an important risk factor of morbidity and mortality. Among different causes of hypertension, RVH has a better response to treatment either by PTA or surgery. RAS usually occurs 3 mo to 2 yr in post-surgery, with a frequency of 3%–16% of all the renal transplants (*1–3*). Recurrence of RAS after PTA and surgery is 33% and 12%, respectively. The RAS results from a wide spectrum of factors, such as the recipient's own atherosclerosis, faulty surgical technique, hemodynamic injury, immunologic reaction, donor's pathology, and donor's age (*1–2*). Pediatric kidney transplant from a donor less than 10 yr of age is a controversial issue among surgeons due to the high degree of urologic and vascular complications (*6,8–10*).

Post-transplant RVH is suspected by the sudden onset of intractable hypertension, worsening of renal function, inefficacy of multiple antihypertensive therapy, fluid retention, and presence of bruit in the iliac fossa. These clinical features are somewhat nonspecific for RAS (*2,11*).

While renal arteriography is the gold standard for RVH assessment (*4,5*), numerous studies of the two-kidney, one-clip hypertension model have demonstrated the usefulness of SDCER (*12–17*). The RAS-affected kidney depends on the renin-angiotension axis to maintain a sufficient glomerular filtration pressure. Captopril, by inhibiting the production of angiotensin II, is thought to affect the autoregulation of the GFR through the suppression of the post-glomerular arteriolar vasoconstriction (*13–17*). Captopril does not interfere with GFR of a normal kidney nor with the effective renal plasma flow of either normal or pathologic kidney (*12,16*). In addition, in entities such as essential hypertension, chronic pyelonephritis, and urinary

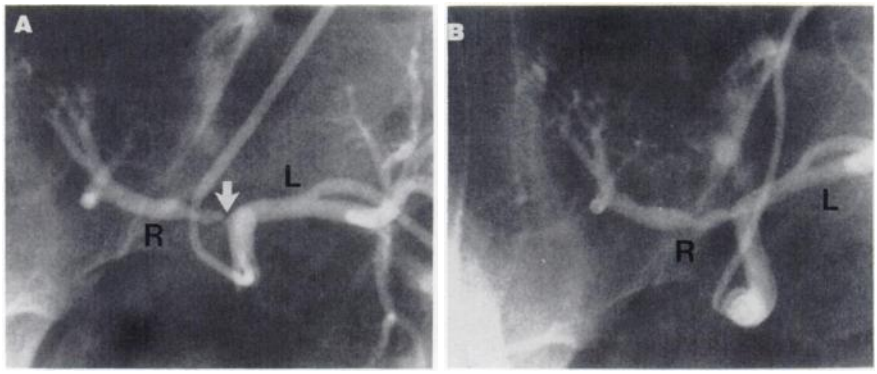

FIGURE 2. The selective renal arteriography shows a high-grade ostial stenosis (arrow) of the right renal artery (A). After percutaneous transluminal angioplasty, there is less stenosis of the right renal ostium (B). (R) right kidney and (L) left kidney.

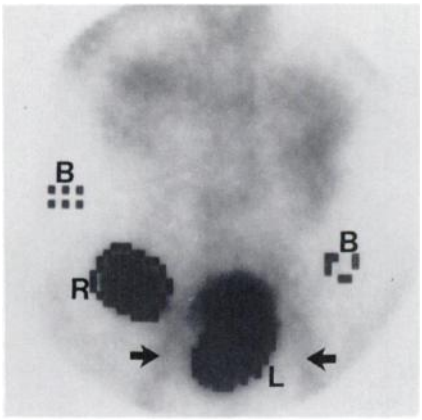

FIGURE 3. Split renal function by Gates' method is performed by drawing a region of interest (ROI) over each transplant in the right iliac fossa and a ROI of the background lateral to each kidney. (R) right kidney ROI; (L) left kidney ROI; a (B) background ROI; and (Arrows) iliac vessels.

obstruction which constitute the differential diagnosis of RVH, Captopril does not produce an asymmetric afferent arteriole tone (*13*). Thus, Captopril enhances the discrepancy of uptake and excretion between the normal and impaired kidney, and allows RAS screening.

There were few publications on post-transplant RVH work-up with SDCER in the literature (*4,5*). In one report (*4*), SDCER was stated to have a high specificity. Unfortunately, its sensitivity was compromised by significant heart failure and transplant rejection. Only one comparative study (*5*) involved both renal arteriography, SDCER, and Doppler sonography. With renal arteriography as a reference for RVH assessment, SDCER was reported to have a higher sensitivity over Doppler sonography. The latter technique relied mostly on the operator's skill. Both mentioned studies (*4,5*) were on single kidney transplant recipients, constituting the one-kidney, one-clip hypertension model. This model is volume/sodium dependent (*15, 16*). The sodium balance influences the GFR response to Captopril and interferes with the SDCER screening of RVH.

Our report focuses on en-bloc transplantation (*6*), which represents the two-kidney, one-clip hypertension model. Through SDCER, unilateral RAS of our double-pediatric kidney transplant behaves similarly to the unilateral RAS of native kidneys. With the reported high survival rate of the en-bloc transplantation technique, SDCER may play an important role in the screening of this two-kidney, one-clip post-transplant RVH.

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