Ultrasonography of the Renal Transplant

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KEYWORDS

• Renal transplant ultrasonography • Graft dysfunction • Renal artery stenosis
• Renal vein thrombosis • Arteriovenous fistulas • Pseudoaneurysms • Peritransplant fluid collections

KEY POINTS

- Signs of renal artery stenosis include color Doppler showing turbulent flow with aliasing at the site of stenosis, peak systolic velocity (PSV) greater than 2.5 m/s in the main renal artery, the ratio of the PSV in the main renal artery to the external iliac artery greater than 1.8, and segmental artery parvus-tardus waveform morphology.
- The differential diagnosis for reversed diastolic flow includes rejection, acute tubular necrosis, renal vein thrombosis, and extrarenal compression.
- Power Doppler should be used when evaluating for graft perfusion and segmental infarcts.
- Acute rejection, acute tubular necrosis, and drug toxicity are the most common causes of early graft failure and are indistinguishable by ultrasonography.
- The time of onset of peritransplant fluid collections can aid in their diagnosis. Hematomas and seromas most frequently occur in the first week. Urinomas occur 1 week to 1 month after transplantation. Lymphoceles and abscess are more common after 1 month.
- Renal transplant patients are at increased risk of developing malignancies, such as lymphoma, renal cell carcinoma, and lung cancer.

ULTRASOUND EXAMINATION OF THE RENAL TRANSPLANT

The routine examination of the transplanted kidney includes grayscale, color Doppler, and spectral Doppler images. Longitudinal and transverse grayscale images of the allograft are obtained to evaluate for peritransplant fluid collections, hydronephrosis, masses, and cortical thickness. Grayscale images of the urinary bladder are obtained. Color Doppler is used to evaluate the patency and flow direction of the main renal artery, at the anastomosis, renal vein, adjacent iliac artery and vein, and intrarenal arteries. Spectral Doppler images are used to measure the peak systolic velocity (PSV) at the arterial anastomosis, any region of aliasing in the main renal artery, and peak velocity in the iliac artery cranial to the anastomosis (**Fig. 1**).[1]

The Doppler resistive index (RI) (= [PSV – end diastolic velocity]/PSV) is a tool for quantifying the alterations in renal blood flow that may occur with renal disease.[1] Duplex images taken of the upper, mid, and lower poles of the kidney within the intrarenal arteries central to the junction of the cortex and medulla are performed routinely

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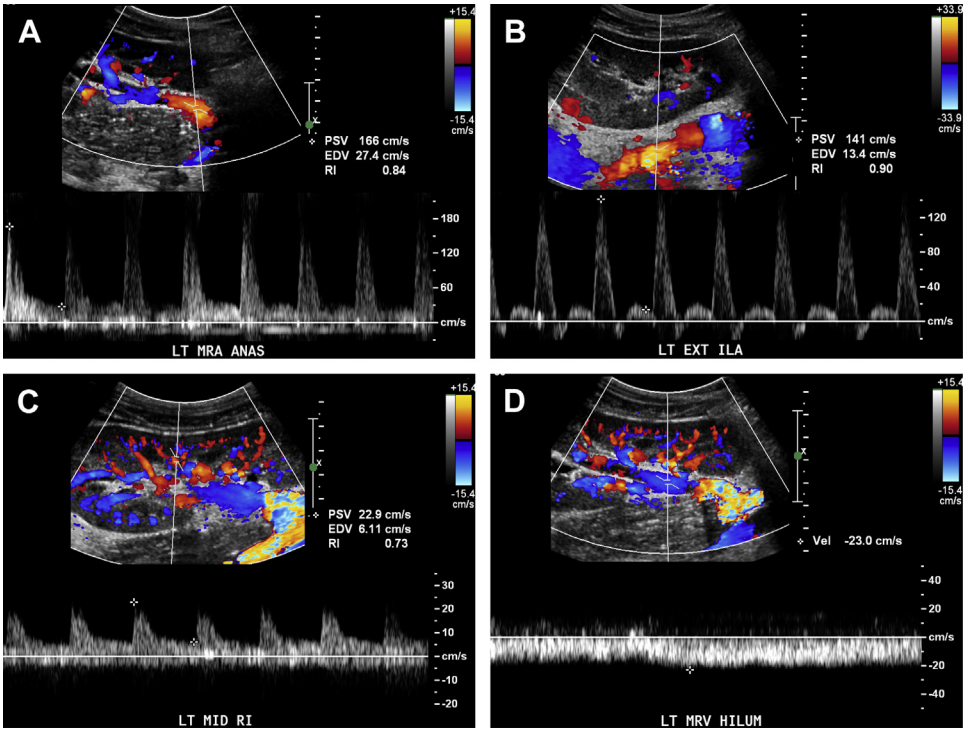

Fig. 1. Normal appearance of renal artery anastomosis without evidence of stenosis. (*A*) Duplex Doppler of the main renal artery shows laminar flow without aliasing and normal velocity lower than 250 cm/s on spectral analysis. (*B*) PSV of the external iliac artery is included to allow calculation of renal artery/iliac artery ratio lower than 1.8. (*C*) Indirect evaluation of the segmental artery shows no abnormal resistance or delayed systolic acceleration. Note that the early systolic peaks in this patient may not always be present even in a normal transplant. (*D*) Main renal vein has normal phasic flow.

for RI measurements.[2] An RI between 0.5 and 0.8 is considered to be within normal limits. Care must be taken to not compress the kidney when scanning the patient, because RI can be artificially increased if too much pressure is used.[3] Although resistive indices are useful in a binary fashion (normal vs abnormal), it is nonspecific in determining the underlying abnormality.

VASCULAR ABNORMALITIES

Vascular complications are uncommon after renal transplantation but are an important cause of early graft loss. A recent review of 1945 live related renal transplants showed vascular complications in 1.29% of patients, with renal artery stenosis representing the most common complication.[4] Although older studies reported a higher prevalence of stenosis, other more recent series have shown the incidence of renal artery stenosis to range from 1% to 3%.[5–8] Renal artery thrombosis is the least common, but most dreaded, vascular complication. Other vascular complications include infarct and renal vein thrombosis. After intervention of a renal allograft, arteriovenous fistula (AVF) and pseudoaneurysm (PSA) may occur.

ANATOMY

The transplanted allograft is routinely placed in the iliac fossa in the extraperitoneal pelvis, most commonly on the right. For cadaveric allografts, the main renal artery and Carrel patch are anastomosed to the recipient external iliac artery in an end to side anastomosis.[9] The Carrel patch is a small cuff of the donor aorta included to reduce the development of transplant renal artery stenosis. For living donor allografts, the main renal artery is most commonly anastomosed to the external iliac or common iliac artery in an end to side manner, but may be anastomosed to the internal iliac artery (hypogastric) in an end to end manner.[9,10] A prospective study[9] with half of the patients having an end to end anastomosis and half having end to side anastomosis showed no difference in graft survival or complications with a 2-year follow-up. In allografts with multiple renal arteries, each individual artery may be anastomosed to the external, internal, or common iliac arteries.[10] Alternatively, the 2 arteries may be anastomosed side to side (ex vivo), resulting in a common stem, which is then anastomosed to the recipient internal iliac artery using an end to end