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Review Article

Imaging in renal transplant: Review

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ABSTRACT

Renal transplantation has transformed the management of end stage renal disease (ESRD), along with prolonging survival it offers good quality of life with low morbidity. Imaging plays an important role in the diagnosis of complications arising in renal transplant. Ultrasound (US) with Doppler is the first-line imaging modality for evaluation of renal graft, with US, Doppler and nuclear medicine being the main imaging modalities. Computed tomography scan (CT), Magnetic resonance imaging (MRI) and digital subtraction angiography (DSA) are used as problem solving tools in indeterminate cases. Interventional radiology plays a crucial role in the management of complications. Use of real time ultrasound guidance for percutaneous biopsy is now almost universal.

1. Introduction

Renal transplantation is the treatment of choice for end stage renal disease (ESRD) patients. With improved transplantation technology, new generations of immunosuppressive agents and developments in graft preservation techniques, short-term of the grafts improved dramatically. However, the improvement in long-term graft survival remains a challenge. Complications arising in the renal allografts are not uncommon. Major causes of renal transplant dysfunction are acute tubular necrosis (ATN), rejection, toxicity from medication, renal artery stenosis, renal vein thrombosis, postrenal biopsy arteriovenous fistula and pseudoaneurysms, urinary leaks and perinephric collections (abscess, lymphocele etc) and graft hydronephrosis. Radiologic imaging plays an important role in evaluation of the graft kidney. The following imaging modalities are used in diagnosis and management of post-transplant complications.

2. Ultrasound

Typically renal transplants are located in false pelvis (in right iliac fossa) and are quite superficial, hence readily accessible

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with US. Advantages of ultrasound include lack of ionizing radiation, portability, less expensive, and lack of potentially nephrotoxic iodinated contrast agents. The operator dependence of US is, however, a relative limitation. Ultrasound is a valuable toolintheimmediatepost-transplantperiodaswellasfor-long-termfollow-up. Gray scale ultrasound appearance of healthy transplant kidney resembles those of a normal native kidney (Fig. 1). Gray scale images are obtained to evaluate for transplant hydronephrosis, peritransplant fluid collections, and renal cortical thickness (Fig. 1). Color Doppler images are obtained to evaluate the patency and direction of flow in transplant arteries and veins (Figs. 2 and 3). Spectral analysis of vascular waveforms and velocities can provide information about a range of pathologies such as renal artery stenosis (Fig. 4).

US is used as a routine study to evaluate the transplant within the first 24 h after transplantation to detect or rule out vascular complications. In the perioperative period, US can detect renal artery thrombosis or renal vein thrombosis.

It is commonly used for first-line evaluation in the setting of transplant dysfunction. Gray scale findings of transplant dysfunction on US include a decreased cortico-medullary differentiation, reduction in renal sinus echoes, increased and reduced renal parenchymal echoes, increased cortical reflectivity. However, these features occur well after the onset of the dysfunction and are arbitrary and inconsistent and hence of limited value.

Doppler indices are suggested for evaluation of renal graft. Many studies in the past have suggested that resistive index (RI) measured by duplex Doppler US is not sensitive or specific in identifying the cause of functional transplant dysfunction.[1,2] However, recent studies have shown that renal arterial RI is useful in predicting graft survival, especially when using a lower RI cut-off of 0.8.[3,4] Allograft recipients with a resistive index of 0.8 or greater have higher mortality than those with a resistive index of less than 0.8 at 3, 12, and 24 months after transplantation.[5] Abnormal resistive indices indicate allograft dysfunction but do not reliably demonstrate the cause. Pulsatility index of greater than 1.8 is considered abnormal.

Doppler US is also a very reliable and noninvasive tool to monitor the effectiveness of revascularization in patients with renal artery stenosis (RAS).[6] Tardus parvus waveform can be seen within the kidney downstream to the stenosis; however, due to the superficial location of the transplant kidney, evaluation of the main renal artery is better. Peak systolic velocity (PSV) in the renal artery is commonly used as the parameter to assess for the presence of renal artery stenosis on Doppler (Fig. 5). Cut-off values of 200–300 cm/s have been proposed for the diagnosis of RAS in various studies.[7,8] An acceleration time (AT) of 90 ms or less, is usually considered as normal. Another parameter that can be used is the renal to iliac artery ratio (RIR), which has been shown to have a sensitivity of 90% and specificity of 96.7% using a cut-off value of 1.8.

As evaluation for renal artery stenosis with US Doppler is operator dependent, magnetic resonance angiography (MRA) or CT angiography (CTA) may be more reliable than with US Doppler.

US appearance of renal artery thrombosis is striking, with complete absence of flow in the renal vessels on color flow and spectral analysis. It is important to remember, however, that absent flow within the kidney can also be seen in patients with hyperacute rejection and renal vein thrombosis.[9] Reversal of flow in the renal artery in diastole has been seen in renal vein thrombosis[10]; however, this reversal has been shown in ATN, rejection, low cardiac output, and nephrosclerosis as well.[11] US is a useful tool for detection of post-biopsy arteriovenous fistulas and pseudoaneurysms, which can affect allograft function if they are large.

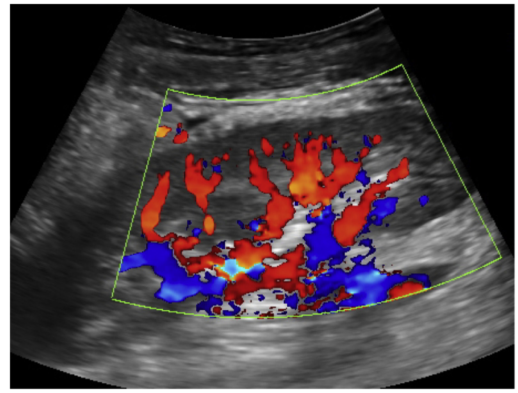

Fig. 2 – Color Doppler image through mid pole of transplant kidney showing normal color flow.

Fig. 1 – Longitudinal gray scale ultrasound through normal transplant kidney.

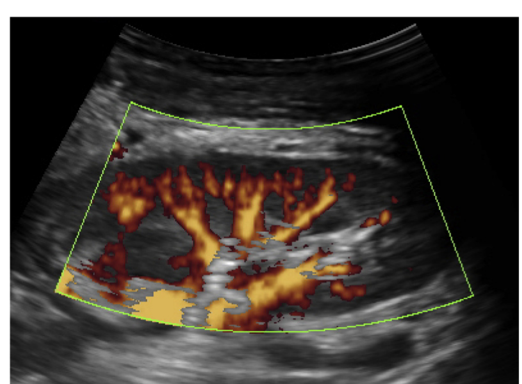

Fig. 3 – Power Doppler image of transplant kidney showing normal flow.