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Renal Transplant Complications: Diagnostic and Therapeutic Role of Radiology

Mehmet Fatih Inci, MD[a,*], Fuat Ozkan, MD[a], Teik Choon See, MB, FRCS, FRCR[b], Servet Tatli, MD[c]

[a]*Department of Radiology, Sütçü İmam University Medical School, Kahramanmaraş, Turkey*
[b]*Department of Radiology, Addenbrooke's Hospital, Cambridge University Hospitals NHS Foundation Trust, Cambridge, United Kingdom*
[c]*Division of Abdominal Imaging and Intervention, Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA*

Abstract

Kidney was the first and is the most frequently transplanted organ. Despite improved surgical techniques and transplantation technology, complications do occur and, if left untreated, may lead to catastrophic consequences. Renal transplantation complications may be vascular (eg, renal artery and vein stenosis and thrombosis, arteriovenous fistula, and pseudoaneurysms); urologic (eg, urinary obstruction and leak, and peritransplantation fluid collections, including hematoma, seroma, lymphocele, and abscess formation); and nephrogenic, including acute tubular necrosis, graft rejection, chronic allograft nephropathy, and neoplasm. Early diagnosis and treatment of these complications are paramount to prevent graft failure and other significant morbidities to the patients. Radiology plays a pivotal role in the diagnosis and treatment of these complications, with minimally invasive percutaneous techniques. In this article, we reviewed renal transplantation anatomy, a wide range of complications that may occur after renal transplantation surgery, typical imaging appearances of the complications on varies imaging modalities, and percutaneous interventional techniques that are used in their treatment.

Résumé

Premier organe à avoir été greffé, le rein est également l'organe le plus fréquemment visé par une transplantation. Malgré les progrès réalisés sur le plan des techniques chirurgicales et des technologies de transplantation, des complications peuvent survenir à la suite d'une greffe rénale et mener à des conséquences désastreuses si elles ne sont pas traitées adéquatement. Ces complications peuvent être de nature vasculaire (p. ex., sténose ou thrombose de l'artère ou de la veine rénale, fistule artérioveineuse et pseudoanévrisme), de nature urologique (p. ex., obstruction des voies urinaires, fuites urinaires et collections liquidiennes peropératoires, notamment hématome, sérome, lymphocèle et formation d'abcès) et de nature néphrogénique, notamment nécrose tubulaire aiguë, rejet de greffe, néphropathie chronique de l'allogreffe et néoplasme. Il est essentiel de diagnostiquer et de traiter rapidement ces complications afin d'éviter l'échec de la transplantation et d'autres morbidités importantes pour le patient. La radiologie joue un rôle de premier plan au chapitre du diagnostic et du traitement de ces complications, en recourant à des techniques percutanées à effraction minimale. Cet article passe en revue les particularités anatomiques de la transplantation rénale, un vaste éventail des possibles complications de la transplantation rénale, les résultats de diverses modalités d'imagerie caractéristiques de ces complications et les techniques d'intervention percutanée utilisées à des fins de traitement.

Key Words: Kidney transplantation; Complication; Diagnostic radiology; Interventional radiology

The first successful renal transplantation (RT) was performed in 1954. Since then, RT has found widespread use worldwide and has become the treatment of choice for end-stage renal disease. With improved transplantation technology and new immunosuppressive agents, 1-year survival rates for grafts are reported to be between 80% and 95%, depending on the type of the graft used. The half-life of grafts from living related donors varies between 13 and 24 years, depending on the match [1]. However, despite all these improvements, postoperative complications still do occur in approximately 12%-20% of patients [2].

* Address for correspondence: Mehmet Fatih Inci, MD, Sütçü İmam University, Medical School, KSU Tıp Fakültesi, Yörük Selim Mahallesi, Hastane Caddesi, 46200, Kahramanmaraş, Turkey.

E-mail address: drfatihinci@gmail.com (M. F. Inci).

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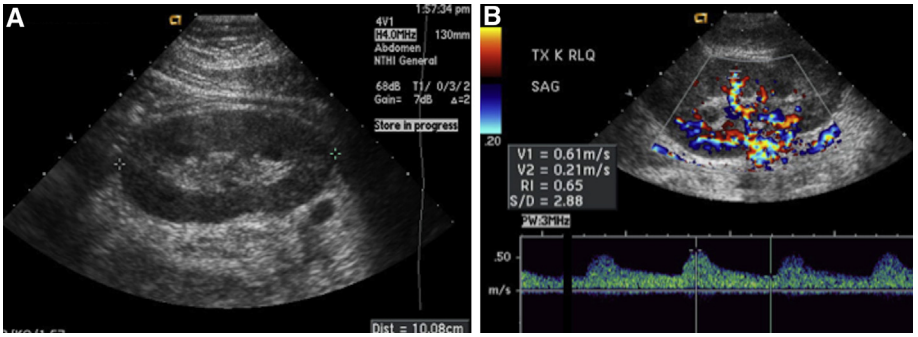

Figure 1. Normal ultrasound (US) findings of a transplanted kidney. (A) Grey-scale US, showing normal size and echogenicity of the kidney. (B) Colour-Doppler US, showing a resistive index within normal limits in the interlobar arteries.

These complications can be divided into 3 categories: vascular, urologic, and nephrogenic. A delay in detection and treatment of any of these complications may lead to loss of renal graft function, morbidity, or even the patient's death.

Imaging Modalities

Ultrasonography (US) is often the first imaging method of choice for transplantation evaluation in the early post-operative period and also is used for long-term follow-up (Figure 1). US can also be used to guide diagnostic and therapeutic interventions, such as biopsy, fluid aspiration, or drainage [3]. It helps to detect parenchymal abnormalities, but its role in differentiating different parenchymal disease processes, such as graft rejection, acute tubular necrosis, or drug toxicity, is limited.

Computed tomography (CT) is useful to demonstrate parenchymal, hilar, perirenal, pyeloureteral, and vascular complications (Figure 2). CT can show fluid collections or hematoma and their anatomic relationship to adjacent structures better than US can, particularly in patients with obesity [4,5]. CT angiography is very useful in depicting vascular abnormalities in the graft artery and in the recipient iliac arterial system without the need for catheter angiography in most cases. CT with coronal and sagittal (and, if needed, oblique) reformatted images can also allow accurate imaging of the entire course of the ureter to look for ureteral and periureteral diseases [4]. However, the administration of considerable volumes of potentially nephrotoxic iodine-based contrast agents may limit its use in patients with RTs, especially for those with renal insufficiency [5].

In more recent years, magnetic resonance imaging (MRI) has evolved into an excellent alternative tool for evaluation of RT and the diagnosis of most complications. Magnetic resonance angiography (MRA) is increasingly used to screen for vascular abnormalities in RTs (Figure 3). Phased-array surface coils provide excellent signal-to-noise information, which permits rapid acquisition of high-quality images [5,6]. The contrast agents used for MRI are safer for the transplanted kidney. However, MRI is expensive and may be contraindicated in certain patients who have a heart pacemaker, a metallic foreign body (metal sliver) in their eye, or an aneurysm clip in their brain, and so forth. Nephrogenic systemic fibrosis is a rare condition, which has been associated with exposure to gadolinium-based contrast agents and recognized as a severely disabling systemic fibroses that resulted in morbidity and mortality. Although it is extremely rare, its incidence is substantially higher, ranging from 2.9%-4.0%, in patients with markedly reduced kidney function and RT [7].

Catheter angiography has been considered as the criterion standard imaging method to evaluate vascular complications of transplanted kidney [8]. Catheter angiography provides luminal data with high spatial and temporal resolution and allows interventions, such as balloon dilation or stent placement. Catheter angiography can also provide physiological data by measuring gradients across stenoses but does not allow any direct visualization of vessel wall and adjacent

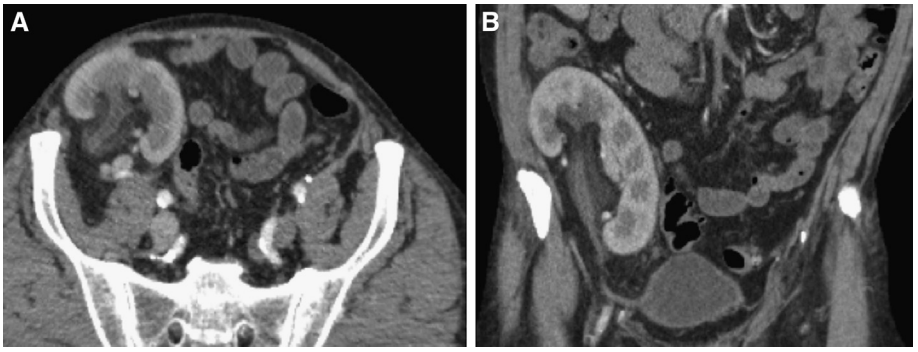

Figure 2. Axial (A) and coronal (B) sections from a contrast-enhanced (cortical nephrogram–phase) computed tomography of normal renal transplantation, showing intense cortical enhancement and mild stranding in the renal pelvis without hydronephrosis or perirenal fluid.