Comparing the Diagnostic Accuracy of Contrast-Enhanced Computed Tomographic Angiography and Gadolinium-Enhanced Magnetic Resonance Angiography for the Assessment of Hemodynamically Significant Transplant Renal Artery Stenosis

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To compare diagnostic accuracy of contrast-enhanced computed tomographic angiography (CTA) and gadolinium-enhanced magnetic resonance angiography (MRA) for the assessment of hemodynamically significant transplant renal artery stenosis (TRAS). After institutional review board approval, records of 27 patients with TRAS confirmed on digital subtraction angiography (DSA) were retrospectively reviewed. A total of 13 patients had MRA and 14 had CTA before DSA. Two board-certified fellowship-trained radiologists, one each from interventional radiology and body imaging blindly reviewed the DSA and CTA or MRA data, respectively. Sensitivity (SN), specificity (SP), positive predictive value, and negative predictive value of MRA and CTA were estimated using 50% stenosis as the detection threshold for significant TRAS. These parameters were compared between modalities using the Fisher exact test. Bias between MRA or CTA imaging and DSA was tested using the Wilcoxon signed-rank test. Two patients were excluded from the MRA group owing to susceptibility artifacts obscuring the TRAS. The correlation between MRA and DSA measurements of stenosis was $r = 0.57$ (95% CI: −0.02, 0.87; $P = 0.052$) and between CTA and DSA measurements was $r = 0.63$ (95% CI: 0.14, 0.87; $P = 0.015$); the difference between the 2 techniques was not significant ($P = 0.7$). Both imaging modalities tended to underestimate the degree of stenosis when compared with DSA. MRA group (SN and SP: 56% and 100%, respectively) and CTA group (SN and SP: 81% and 67%, respectively). There were no significant differences in detection performance between modalities ($P > 0.3$ for all measures). We did not find that either modality had any advantage over the other in terms of measuring or detecting significant stenosis. Accordingly, MRA may be preferred over CTA after positive color Doppler ultrasound screening when not contraindicated owing to lack of ionizing radiation or nephrotoxic iodinated contrast. However, susceptibility of artifacts owing to surgical clips at the anastomosis may limit diagnostic utility of MRA as found in 2 of 13 patients. Trend towards no significant difference between the CTA and enhanced MRA in the detection of hemodynamically significant TRAS.

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Introduction

The number of kidney transplant surgery performed has significantly increased with more than 16,000 kidney transplants performed in the United States alone in 2012.[1]

Although improvements in surgical techniques and the availability of new immunosuppressive drugs have lowered the morbidity and mortality of the surgery, vascular and nonvascular postoperative complications still occur.[2] Recent onset or refractory hypertension and increasing serum creatinine levels are the most common presentations of graft dysfunction.[3] Vascular complications are the most common cause for both morbidity and mortality in the renal transplant recipients.[4] These include transplant renal artery stenosis (TRAS), arteriovenous fistulas, or intrarenal pseudoaneurysms following biopsy, extrarenal pseudoaneurysm, and arterial or venous thrombosis. TRAS is the most frequent of these, occurring in 1%-23% of cases usually in first 3 months to 2 years after transplantation.[5] Nonvascular complications include urologic complications such as ureteral obstruction and urinary leak, and perigraft fluid collections such as hematoma, abscess, urinoma, and lymphocele.[2]

As laboratory data and physical examination are nonspecific and are insufficient to differentiate between vascular and nonvascular causes of the graft dysfunction,[6] catheter angiography is considered the gold standard for the diagnosis of TRAS.[3] Owing to complications associated with catheter angiography, it is currently being used for cases where there is high suspicion for significant TRAS demonstrated on noninvasive imaging.

Noninvasive imaging commonly used to assess the vasculature of the transplanted kidney includes color Doppler ultrasound (CDU), captopril renography, contrast-enhanced computed tomographic angiography (CTA), and gadolinium-enhanced magnetic resonance angiography (Gd-MRA). CDU (sensitivity [SN] and specificity [SP] of 100% and 75%, respectively) and captopril renography (SN and SP of 75% and 67%, respectively)[6] play an important role in the initial screening process for the diagnosis of TRAS. Although CDU is an excellent screening test with very high SN, false-positive results can occur in up to 20% cases.[6] Owing to higher SP of CTA and MRA when compared with the initial screening CDU in the detection of hemodynamically significant TRAS, the CTA or MRA comes in to role in between the screening CDU and the invasive and confirmatory catheter angiogram. Currently, there is no consensus on which one of these is preferred over the other.

Although there are many studies that describe the role of both Gd-MRA[1-10] and contrast-enhanced CTA[11,12] for the diagnosis of TRAS, to the best of our knowledge, there are no studies published in the English literature that compare the diagnostic accuracy of Gd-MRA and CTA in the assessment of hemodynamically significant TRAS. Thus, the purpose of this study was to compare the diagnostic accuracy of contrast-enhanced CTA and enhanced MRA for the assessment of hemodynamically significant TRAS.

Materials and Methods

Patients

The local institutional ethical committee approved this Health Insurance Portability and Accountability Act–compliant retrospective study. Between August 2005 and May 2012, 27 patients who were referred for digital subtraction angiography (DSA) to evaluate TRAS and had undergone CTA or Gd-MRA within 3 months before the DSA procedure were included in this study. The CTA or Gd-MRA were randomly requested by the clinical team or recommended by the radiologist or both depending on their individual preferences, as there is no consensus regarding which of the 2 modalities is better. Indications for the imaging studies were elevated creatinine level (>1.5 mg/dL) and new-onset or refractory hypertension.

Imaging

Computed Tomographic Angiography

Details of the protocol are described in Table 1. The CTA in 14 patients was performed on a GE 64-slice multidetector CT (GE Healthcare Light Speed VCT, ML). For the diagnostic scan, a 100-mL contrast bolus of iodixanol (Visipaque 320, GE Healthcare, Ireland cork, Ireland) was administered intravenously at a rate of 4-5 mL/s, which was followed by a 50-mL saline chase with the same rate of injection. Scan acquisition was performed after a 20-mL timing bolus, at timing bolus peak +5 seconds.

Magnetic Resonance Angiography

Post–gadolinium MRA in all 13 patients was performed on a 1.5-T scanner (Philips Acheiva, Philips Medical system B.V., the Netherlands). Details of the protocol are described in Table 2. Intravenous 20 mL of ProHance (Gadoteridol 279.3 mg/mL, Bracco, Germany) at a rate of 1.6-2.0 mL/s. Scan acquisition was performed with bolus tracking when contrast was first seen in the common iliac arteries.

TABLE 1. CTA protocol

Scanned region	Iliac crest to ischial tuberosity
Phases	Three phases (noncontrast, arterial, and delayed 90 s from start of injection)
Type	All 3 phases are helical 0.4-0.8-s duration
Pitch	1.375:1
Slice thickness and slice interval	0.625-mm thick/0.625 interval and 40-mm detector coverage
Reconstruction	Standard soft tissue algorithm with 2.5-mm thickness
Matrix	512 × 512
kVp	100 kVp for BMI < 20 or FOV < 34 cm 120 kVp for BMI > 20 or FOV > 34 cm
Noise index	30 for BMI < 20 or FOV < 34 cm 36 for BMI > 20 or FOV > 34 cm

BMI, body mass index; FOV, field of view.