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ORIGINAL ARTICLE

The value of 16-slice multidetector computed tomographic angiography in preoperative appraisal of vascular anatomy in potential living renal donors

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KEYWORDS

16-Slice MDCT renal angiography;
Renal artery;
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Preoperative

Abstract *Background:* Comprehensive preoperative appraisal of potential living renal donors is the key for selecting a proper donor and a suitable kidney.
Objective: To prospectively assess the diagnostic value of 16-slice multidetector computed tomography (MDCT) in preoperative appraisal of vascular anatomy in potential living renal donors.
Materials and methods: Preoperative angiography using a 16-slice MDCT scanner was performed in 68 consecutive potential living renal donors. The MDCT angiography included unenhanced and contrast-enhanced multiphasic scans. The MDCT images were reviewed for the number and branching pattern of the renal arteries and for the number and presence of major or minor variants of the renal veins. The results were compared with the actual anatomy at the open donor nephrectomy as the diagnostic standard of reference.
Results: The sensitivity and the specificity of MDCT angiography for the detection of various anatomic variants of renal arteries as well as renal venous anomalies were 100%. The anatomic variants of renal arteries included accessory arteries ($n = 7$) and early arterial branching ($n = 10$). Whereas, the detected venous anomalies were of major category of the circumaortic left renal vein anomaly ($n = 2$). No minor renal venous anomaly was identified in any subject.
Conclusion: 16-Slice MDCT angiography is highly accurate for preoperative assessment of diverse anomalies of the renal vascular anatomy in potential living renal donors; in consequence, it markedly affects the surgical planning.

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1. Introduction

Kidney transplantation is limited by severe shortage of cadaver kidneys (1). To ameliorate this limitation, use of living donors is now widely accepted, in particular because it results in better recipient and renal graft survival (2,3). Potential living

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renal donors must undergo screening to determine their suitability for donation (4). Comprehensive preoperative evaluation of potential renal donors is crucial for selecting a proper donor and a suitable kidney. Traditionally, living renal donors have undergone preoperative evaluation with excretory urography and renal catheter angiography. Renal catheter angiography was performed to assess the number of renal arteries, prehilar branching and any vascular disease (5). However, it is an invasive procedure and has limited value in detailed assessment of renal venous anomalies (6). On the other hand, excretory urography depicted renal size, stone disease and pelvicalyceal anatomy. Nevertheless, both methods failed to depict small stones, subtle masses and detailed information about venous abnormalities (4).

It has been shown that evaluation of potential renal donors with excretory urography and renal angiography can be replaced with computed tomography (CT) (7). Consequently, multidetector computed tomography (MDCT) angiography is currently replacing catheter angiography and excretory urography for preoperative evaluation of potential renal donors (5). Introduction of MDCT angiography had a groundbreaking impact on evaluation of the renal vessels (8). The advent of MDCT scanners has provided short image acquisition time, narrow collimation, improved temporal and spatial resolution, decreased motion and partial volume artifacts and near isotropic data acquisition (9). CT angiography (CTA) can reliably and accurately depict the renal arteries and veins and approaches the accuracy of conventional angiography in the assessment of most vascular abnormalities (10). The number, size, branching pattern, course and relationship of the renal arteries and veins are easily demonstrated by MDCT angiography (4,11).

To the best of our knowledge, there are limited literatures regarding the diagnostic accuracy and the value of 16-slice MDCT in preoperative assessment of renal vascular anatomy in potential living donors with surgical confirmation. In the current study, we investigated the diagnostic accuracy of MDCT angiography as the primary imaging technique in preoperative detection of various anatomic variants of renal arteries and veins in potential living renal donors compared to the surgical findings of open nephrectomy.

2. Materials and methods

2.1. Subjects

This is a prospective study conducted from June 2012 to February 2013. 68 consecutive potential renal donors were enrolled in this study (47 men and 21 women). These patients gave their written informed consent and were included in the order in which they showed up. The protocol of our study was approved by the Committee of Ethics. Subjects with abnormal renal scitigraphic results or with a history of allergy to iodine contrast were excluded from our study. Additionally, exclusion criteria incorporated subjects with renal or ureteral structural abnormalities which preclude donation, horseshoe kidney, renal or ureteral calculi, renal neoplasm, hydronephrosis, etc. Nevertheless, renal artery stenosis, calcification or fibromuscular dysplasia was also on our exclusion list.

2.2. Acquisition and processing of MDCT angiography

2.2.1. MDCT angiography scanning protocol

All MDCT renal angiographic studies were performed using a 16-slice MDCT scanner (Somatom Sensation 16, Siemens Medical Solutions, Erlangen, Germany). The scanning MDCT angiography protocol consisted of unenhanced and intravenous (IV) contrast-enhanced multiphasic scans (arterial, nephrographic and excretory phases). The subjects were fasted for an interval of 3 h prior to the examination. A large-bore 18- to 20-gauge IV line is placed in the antecubital vein under complete aseptic conditions. The patient was instructed in breath-hold technique for about 20 s. First, an initial scout topogram was obtained. Scanning started from dome of the diaphragm down to the pelvis in the unenhanced phase using a slice thickness of 3 mm to rule out calculi and to provide a baseline study to compare the enhancement of eventual lesions.

After unenhanced CT scans, the dose of contrast media/body weight was 1.5 ml/kg of non-ionic iodinated contrast containing 300 mg/mL of iodine (Ultravist 370; Schering AG, Berlin-Wedding, Germany) was injected through the peripheral venous line via a pump injector (Envision CT; Medrad, Indianola, PA) using a pressure of 150 at a rate of 4 ml/s. Just after the contrast injection, a total of 40 ml normal saline was injected at 2 ml/s to increase the efficiency of contrast enhancement by allowing the residual contrast material in the veins to be pushed into the arterial system. The start time of arterial phase scanning was determined using automatic bolus tracking or bolus triggering method as the use of a bolus triggering device ensures appropriate scan timing.

The region of interest (ROI) was placed on the abdominal aorta at the level of the renal arteries. Image acquisition was initiated 5 s after a threshold of 125 HU was reached in the ROI. The region of interest for volumetric scanning, in arterial and nephrographic phases extends from the suprarenal abdominal aorta to the iliac artery bifurcation (common iliac arteries). In term of bony landmarks, the scanned area extended from diaphragm to the iliac crest level to ensure scanning the region from the suprarenal abdominal aorta to the iliac artery bifurcation where the main and accessory renal arteries originate. The slice thickness was 0.9 mm in the arterial and nephrographic phases to ensure visualization of small accessory renal arteries, since, a minimum of 1-mm sections should be used for arterial and nephrographic phases to provide better visualization of the lumbar veins and accessory renal arteries which can be small and easily missed when thicker sections are used. Consequently, the image acquisition started at 5 and 80 s after IV contrast administration for the arterial and the nephrographic phases respectively.

For all the patients in this study, MDCT renal angiography was performed using the following parameters: a peak voltage of 120 kVp, 225 eff. mAs, rotation time of 0.5 s, a detector collimation of 0.75 mm and reconstruction with 60% overlap. The unenhanced phase was acquired using a peak voltage of 90 kVp. For both the arterial phase and the nephrographic phase, the images were reconstructed at 0.75-mm thickness with a 0.6-mm. The delayed phase was acquired in a similar fashion to the unenhanced phase to assess the renal collecting system and ureters, thus, allowing the detection of any renal or ureteral exclusion criteria that preclude donation using the same slice thickness of 3 mm but acquired with a delay of 5 min.