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

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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.

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
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 decreased radiation dose. 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 (9). 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 scintigraphic 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, hydrenephrosis, 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, Indianapolis, 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 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.
Afterward, data were transferred over the network to an imaging workstation (Vitrea 2, Vital Images) that allows real-time interactive manipulation of images and processing image reconstruction. The obtained axial source images were postprocessed to produce two dimensional (2D) and three dimensional (3D) reformatted images simulating conventional angiograms. The used postprocessing techniques included multiplanar and curved planar reformations (MPR and CPR), maximum intensity projection (MIP) and volume rendering (VR).

2.3. Image analysis

Two independent radiologists having a board-certified license and more than 7 years of experience reviewed the whole data set. They evaluated the performed MDCT examination to primarily document the acceptability of its technical quality to further evaluate renal vascular anatomy. Both; axial source images and postprocessed images were evaluated. The former was used as the basis for diagnosis and for the evaluation of the possible presence of an accompanying non-vascular pathology. MIP was used as it brings out high-attenuation, high-contrast well-defined structures in variable projection angles offering an overview of vascular anatomy. Alternatively, VR was used to provide a single, comprehensive vascular map of the arteries and veins especially displaying complex anatomy of the overlapping vessels. On the other hand, MPR and CPR, processing data from axial CT images to create non-axial two-dimensional coronal, sagittal, oblique or curved plane images, were utilized for the analysis of small, less well-opacified vessels with CPR adjusted through setting the curve axis along both main renal arteries and veins. Renal arterial and venous anatomy was assessed frequently on the arterial phase images. The renal arteries were assessed for the number and branching pattern, whereas, the renal veins were assessed for the number and presence of major or minor variants of the renal veins. If the renal veins were not enhanced on the arterial phase images, the nephrographic jor or minor variants of the renal veins. If the renal veins were assessed for the number and presence of major or minor renal vein anomalies applying the same criteria used in MDCT angiography.

2.4. Surgical correlation

The included 55 subjects underwent donor nephrectomy using open extraperitoneal approach. Surgery was performed within 4 weeks after the MDCT angiography examination. The donated kidney was selected on the basis of the MDCT angiography data. The main consideration after applying the previously mentioned exclusion criteria was the presence or absence of complex vascular anatomy. The left kidney was preferred for donation if having a simple vascular anatomy because of the greater length of its vein. Intraoperatively, the transplant surgeon recorded the surgical result for each kidney as follows: the number, location and course of renal arteries and the presence of early branching arteries as well as the presence of major or minor renal vein anomalies applying the same criteria used in MDCT angiography.

2.5. Statistical analysis

The gained results of MDCT angiography were compared with the findings at the open nephrectomy which represents the standard of reference for the actual anatomy. This was done using the standard formulas to determine the sensitivity and the specificity of the MDCT angiography and hence, its diagnostic accuracy to detect the anatomic variants of renal arteries and the minor and major renal venous anomalies per donated kidney.

3. Results

We excluded a total number of 13 subjects; 12 of them had renal and ureteral structural abnormalities as given in Table 1 and the remaining one with abnormal renal scintigraphic results. Consequently, 55 subjects (38 men and 17 women; age range, 23–43 years; mean age, 28 years) were included in the

<table>
<thead>
<tr>
<th>Abnormality</th>
<th>Number of subjects</th>
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<tr>
<td>Horseshoe kidney</td>
<td>1</td>
</tr>
<tr>
<td>Simple renal cyst</td>
<td>3</td>
</tr>
<tr>
<td>Renal calculi</td>
<td>4</td>
</tr>
<tr>
<td>Ureteral calculi</td>
<td>3</td>
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<tr>
<td>Bilateral complete ureteral duplication</td>
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current study. They underwent MDCT angiography using a 16-slice MDCT scanner and open donor nephrectomy. All included subjects successfully underwent MDCT renal angiography without allergic reaction to the contrast material or contrast medium extravasation. In all included 55 subjects, the two independent experienced radiologists evaluated the MDCT angiographic images for technical verification. The gained MDCT findings were confirmed by these of the open nephrectomy surgery. Additionally, the renal arteries and veins were adequately enhanced on the arterial phase images in all patients with stronger enhancement of the renal arteries than did the renal veins. This made it easy to differentiate the renal arteries from the renal veins.

We used the delayed phase to corroborate the renal or ureteral structural abnormalities which preclude donation. The delayed phase showed 1 subject with bilateral complete ureteral duplication. Nevertheless, the remaining subjects having renal and ureteral structural abnormalities, who were also excluded from our study, were relevant by other phases.

On the basis of MDCT angiography findings, 53 subjects (96%) underwent left nephrectomy, while, two subjects (4%) underwent right nephrectomy. Right nephrectomy was performed in these two subjects since the preoperative MDCT angiography showed three accessory renal arteries (four left renal arteries) with an early branching right renal artery in one subject. While, the preoperative MDCT angiography showed an accessory left renal artery (two left renal arteries) and an accessory left renal vein (duplicated left renal vein) with an early branching right renal artery in the other subject.

### 3.1. Renal arteries

38 of the 55 donated kidneys (69%) displayed normal renal arterial anatomy (Fig. 1), while, 17 of the 55 donor kidneys (31%) showed surgically relevant anatomic variants of renal arteries; 7 kidneys (13%) with one accessory artery and 10 kidneys (18%) with early branching arteries were observed. Moreover, according to the course of the accessory renal arteries, all of them were categorized into polar; two were upper and five were lower. Alternatively, a total of 62 renal arteries were identified during surgery in the 55 donor kidneys. One renal artery in 48 donor kidneys (87%) and two renal arteries in 7 donor kidneys (13%) were identified. All of the seven accessory arteries were in the left kidneys, whereas, renal arteries with early branching were 8 and 2 on the left and right sides respectively. Consequently, MDCT angiography properly identified all of the 62 renal arteries in the 55 donor kidneys when compared with the surgical findings showing the 7 accessory renal arteries (Table 2) (Figs. 2 and 3); 2 upper polar and 5 lower polar. Additionally, MDCT angiography diagnosed 10 of the 62 renal arteries with early branching (8 on the left side and 2 on the right side) (Figs. 4–7) which were confirmed by the surgical findings (Table 2). As a result, the sensitivity and the specificity of MDCT angiography for the detection of various anatomic variants of renal arteries were 100%. Moreover, we did not identify any subject having calcifications at the ostium of the main renal arteries. A note is made of better visualization of the normal segmental renal artery using MIP (Fig. 1), whereas, the extraparenchymal vasculature of accessory renal arteries (Fig. 3) and early arterial branching (Fig. 6) with their 3D relationships were well demonstrated using VR.

![Fig. 1](image-url) A 43-year-old man who underwent left donor nephrectomy. Axial MIP image (A), coronal VR image (B) and coronal MIP image (C) display normal both renal arteries (yellow arrows) with their origin below that of the superior mesenteric artery (black arrow in B). Coronal MIP image posterior view (D) visualizes well the normal segmental anatomy of the right renal artery (arrowed).
3.2. Renal veins

At surgery, 53 of the 55 donated kidneys (96%) displayed normal renal venous anatomy (Fig. 8), while, 2 of the 55 donor kidneys (4%) showed major renal venous anomalies of circumaortic left renal vein anomaly (Fig. 9). Similarly, MDCT angiography enabled a correct diagnosis in the two subjects of major renal venous anomalies (Table 2) with sensitivity and specificity of 100%. No minor venous anomalies were identified in any subjects. Similar to the extraparenchymal vasculature of accessory renal arteries and early arterial branching, duplicated left renal vein was better visualized with its 3D relationships using VR than MIP as shown in Fig. 4.

4. Discussion

Accurate evaluation of donors, in particular their renal anatomy and vasculature, is highly important for screening donors, planning surgery and preventing complications (12). Potential living renal donors should undergo comprehensive preoperative assessment including clinical evaluation, laboratory tests and diagnostic imaging (5). Conventional angiography is traditionally regarded as the gold standard imaging modality for evaluation of the renal vasculature (8).

However, angiography has limited value in detailed evaluation of complex renal venous anomalies. It also has serious complications such as intimal injury, dissection and subsequent stenosis of the vessel (6).

CTA provides significantly more information than intravenous urography (IVU) and angiography together, especially regarding abdominal anatomy and vascular pathways (13). Moreover, CTA consists of only one technique and can be done in just 1 day, as opposed to IVU and angiography which needed a minimum of 2 days because of contrast restriction. This fact also implies an overall cost reduction of the procedure that has been reported to be of 35–50% (14).

Albeit, magnetic resonance (MR) angiography is an acceptable alternative non-invasive imaging modality in renal donors as no iodinated contrast material or ionizing radiation is used (15–18), MRA has some limitations. These limitations include motion artifacts, phase encoding artifacts, vascular pulsation and chemical shift artifacts at fat-soft tissue interfaces especially in the retroperitoneum. All these artifacts can cause misdiagnosis of small vessels. On the other hand, CT angiography permits higher spatial resolution, given that MRA pulse sequences do not allow scanning with a thickness of 1 mm or less (19). Moreover, the study which was performed by Rankin et al. (18) showed that CTA visualized 37 of the 40 arteries identified at surgery with a detection rate of 93%, whereas, MRA visualized 18 of the 20 arteries identified at surgery with a detection rate of 90%.

It is well known that optimal timing of image acquisition and meticulous management of the patient, including preparation, positioning and contrast injection technique, is crucial. Moreover, in the majority of institutions, the study comprises a multiple phase procedure including at least two of the following phases: unenhanced, arterial, nephrographic and delayed (19). Likewise, we performed the four phases in our study. We used the delayed phase to detect the pelvicalyceal system and ureteral anomalies that may render the subject unfit for donation. As well, we assumed that transferring the patient to the X-ray suite to obtain conventional radiography instead of the delayed phase would be more complicated and time consuming. Additionally, the delayed phase is always with a low-dose acquisition (19). Moreover, we used the nephrographic phase instead of the venous phase corresponding to Kawamoto

<table>
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<th>Type of anatomical variant</th>
<th>Preoperative evaluation, Number</th>
<th>Findings during surgery, Number</th>
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<td>Accessory arteries</td>
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<tr>
<td>Early branching</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Circumaortic left renal vein</td>
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Fig. 2 A 27-year-old woman who underwent left donor nephrectomy. Coronal VR images (A and B) in anterior and posterior views respectively show an accessory polar renal artery coursing to the lower pole of the left kidney (white arrow) with early branching of the right renal artery (yellow arrow).

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et al. (20) who established that the venous phase with a 55-s delay is not optimal for the depiction of renal neoplasms, a criterion for exclusion as a donor. The nephrographic phase also provides a proper enhancement of both renal and small tributary veins (19). On the other hand, we employed the arterial phase as it allows the depiction of not only the renal arteries but also the renal veins (4,19). We also reduced the tube current to 90 kVp in the unenhanced phase to reduce the radiation dose to which the potential donors are exposed. As although reducing kilovolt peak (<100 kVp) in the precontrast phase results in more image noise, the images are still diagnostically satisfactory and the radiation dose is significantly reduced (21).

Although some authors (22) advocate using water as a negative agent, in the current study, no orally administered contrast agents were given for the 3D rendering. Considering CTA, apart from the quality of the source CT data, the reconstruction method is the most important factor affecting the

Fig. 3 A 33-year-old woman who underwent left donor nephrectomy. Coronal VR images with overy of surroundings (A) and with clipping of the surroundings (B) and coronal MIP image (C) display a lower polar left-sided accessory renal artery (arrowed). Axial MIP image (D) shows two arteries (arrowed) arising from the left lateral wall of the aorta at the expected level of the left main renal artery.

Fig. 4 A 32-year-old man who underwent right donor nephrectomy. Coronal VR image (A) and coronal MIP image (B) show an accessory upper polar left renal artery arising proximal to the origin of the main one by 6 mm (continuous white arrow). Early branching of the right renal artery (dashed white arrow in B) is noted within 9 mm from the right lateral wall of the aorta. A duplicated left renal vein (yellow arrows in A) is also seen forming a common vein that runs a pre-aortic course.
quality of CT angiographic images (23). Each reconstruction method has advantages and limitations dictated by its own working algorithm (24). The utility of the VR technique has been documented for demonstrating both arterial and venous disease which is crucial to detect before surgery. In VR, the overlying structures are easily removed with an interactive clip plane and the vessels of interest are easily rotated into the best orientation for visualizing the region of interest. Alternatively, MIP views provide additional information and complement conventional volume-rendered images (22).

Similarly, we found that VR CTA allocated the renal vascular anatomy precisely in conjugation of MIP which added more anatomical details. Better visualization of the normal segmental renal artery was obtained using MIP, whereas, the extraparenchymal vasculature including accessory renal arteries and early arterial branching and duplicated renal vein with their 3D relationships were well demonstrated using VR. Moreover, it has been obtained that for CT angiographic evaluation of living renal donors; thin-slab reconstruction is superior to thick-slab reconstruction. This is owed to the fact that with the thin-slab reconstruction technique, the risk of adjacent structures obscuring or mimicking renal vessels can be reduced and less time is required. While with thick-slab reconstruction, many voxels with various attenuations are grouped together (23). Therefore, small vessels should be evaluated with thin sections since usually they are not visible because of their low attenuation (25). As well, we used VR and MIP of thin-slab throughout our study.

Regarding the anatomy of main renal vessels, MDCT angiography in the current study accurately detected the anatomy of the main renal arteries and veins. This was comparable with that attained by Türkvatan et al. (5) and Zhang et al. (26). Presurgical evaluation of accessory arteries and early branching of the renal artery is particularly important in deciding which kidney to donate (2). Moreover, presurgical detection of accessory arteries can minimize blood loss and possibly avoid a focal renal infarct (26).

Just as important is the detection of the proximal branching of the renal artery, in particular, the prehilar branches occurring within 2 cm of the origin of the renal artery from the aorta (20,26). In addition, an early branching renal artery is considered technically similar to a double renal artery (2). Accordingly, the transplant surgeon in the current study attempted only one anastomosis in early arterial branching to minimize the time of ischemia because at least a 2 cm length of renal artery before hilar branching is required to guarantee satisfactory control and adequate anastomosis (4,20).

According to the course of the 7 accessory renal arteries, all of them were categorized into polar; two arteries reaching the upper pole and 5 arteries reaching the lower pole. No hilar accessory renal artery was identified. The importance of polar arteries is shown in the fact that they supply the renal parenchyma and when damaged during nephrectomy it can cause arterial bleeding or renal infarction. A case particularly worth mentioning is inferior polar arteries that provide vessels for the upper excretory system. Thus, a section of an inferior polar artery can cause pyeloureteral necrosis of the graft leading to stenosis or urinary tract leakage (27).

There are far more variants of veins than on the arterial side (19). CTA can provide complete evaluation of venous anomalies with accuracy comparable with that of conventional angiography (28). The reported accuracy of MDCT in the
evaluation of renal venous anatomy ranges from 93% to 100% in the evaluation of major renal venous anomalies (29). Identification of minor renal venous renal anomalies including the presence of draining prominent (> 5 mm) gonadal or lumbar veins and drainage of any associated small renal vein branch into these veins have not been well characterized by imaging (30). MDCT does not consistently demonstrate veins smaller than 3 mm, whereas, clinically significant veins thicker than 3 mm can be identified using MDCT with high sensitivity and specificity (19). Consequently, in most of the prior studies,

Fig. 6  A 32-year-old man who underwent left donor nephrectomy. Coronal MIP image (A), coronal VR images with overly of the surroundings (B) and with clipping of the surrounding (C) show early branching of the left renal artery (arrowed) within 1 cm from the left lateral wall of the aorta.

Fig. 7  A 31-year-old woman who underwent left donor nephrectomy. Coronal VR image (A), coronal oblique MIP image (B) and coronal MIP curved image (C) and axial MIP image (D) display early branching of the left renal artery (white arrow) within 5 mm from the lateral wall of the aorta with an accessory renal artery (yellow arrow in A–C) to the lower pole of the right kidney originating 2 cm distal to the origin of the ipsilateral main artery.
Fig. 8 A 28-year-old man who underwent left donor nephrectomy. Axial MIP images (A–C) show normal left renal vein (arrowed). Coronal MIP curved image (D) shows the left renal vein (blue arrow) normally courses anterior to the left renal artery before draining into the medial aspect of the inferior vena cava (IVC). While, the right renal vein (red arrow) drains to the lateral aspect of the IVC. The IVC is marked by asterisk.
only major venous variants were evaluated, whereas, the minor venous ones have not been studied extensively (5). Nevertheless, MDCT protocols should be optimized to maximize the enhancement of the small vessels of minor renal venous anomalies since identifying some variants can be difficult because of complexity, variability (30), their small diameters and poor opacification (5).

The most common venous variant is the presence of multiple or supernumerary renal veins which can be seen in approximately 15%–30% of individuals (31). Multiple right renal veins occur in up to 30% of individuals and sometimes a single vein may divide before joining the inferior vena cava (32). On the other hand, circumaortic left renal vein has 2.4%–8.7% prevalence (33) and a single retroaortic left renal vein is present in 2%–3% of individuals (34). We demonstrated by MDCT angiography one accessory renal vein (duplicated left renal vein) in 1 subject out of 55 subjects and circumaortic left renal veins in 2 subjects out of 55 subjects. The latter venous anomaly was surgically correlated. Alternatively, Türkvatan et al. (5) detected at surgery major renal venous anomalies of accessory renal veins in 3 subjects, late venous confluence in 4 subjects, circumaortic left renal veins in 2 subjects and retroaortic left renal veins in 3 subjects. Consequently, in the current study, the accessory renal vein and circumaortic left renal vein were found in 1.8% and 3.6% respectively. This is compared to 5% for the accessory renal vein and 1.3% for the circumaortic left renal vein as obtained by another study (2).

We did not identify any subject with minor renal venous anomaly. Nevertheless, the sensitivity for the identification of a minor renal venous variant was 79% in the study carried out by Türkvatan et al. (5). As all subjects in the current study underwent nephrectomy with the open approach, less attention was paid to the veins. Additionally, some authors believe that presurgical imaging of renal venous structures is not as crucial as the imaging of arteries (35) because free anastomoses exist between the intrarenal veins throughout the kidney (36) opposed to the intrarenal arteries (19). On account of this network, ligation of the venous branches can be performed if one vessel is cut or damaged during surgery, permitting an alternate flow and avoiding the risk of parenchymal loss (19). From a clinical point of view, veins smaller than 3 mm are irrelevant as they could be cut and sealed during dissection without substantial bleeding (37) or risk of parenchymal loss (36). Furthermore, laparoscopic nephrectomy, unlike conventional open surgery, is performed with a limited view of the venous anatomy (22) because the posterior aspect of the renal vein often cannot be directly visualized during surgery (5). Therefore, the presence of venous anomalies constitutes a potential surgical nightmare if they are not documented in advance (22).

Our use of the nephrographic phase instead of the venous phase concurred with the study done by Türkvatan et al. (5) who elucidated that not only major renal venous anomalies are well depicted during the arterial phase, but also the minor renal venous anomalies are not well opacified during the venous phase. Moreover, they established that the dual-phase MDCT angiography (acquiring arterial and nephrographic phases) had sensitivity of 79% and 100% for the identification of minor renal venous anomalies and major renal venous anomalies respectively.

The diagnostic accuracy of 16-slice MDCT angiography for preoperative detection of various anatomic variants of renal arteries and veins in potential living renal donors in our study...
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was corresponding to that obtained by Zhang et al. (26) who used 64-slice MDCT angiography.

To conclude, unenhanced and IV contrast-enhanced multi-phase scans (arterial, nephrographic and excretory phases) 16-slice MDCT angiography is a robust non invasive modality that properly detects diverse anomalies of the renal vascular anatomy in potential living renal donors. It not only detects the renal and ureteral structural abnormalities that preclude renal donation but also decides which kidney to donate. Hence, 16-slice MDCT angiography is an adequate procedure in potential living renal donors.

Conflict of interest

We have no conflict of interest to declare.

References

