3-D Spiral Computerised Tomographic Angiography in Evaluation of Potential Renal Donors

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Abstract

A total of 30 potential renal donors aged between 35 and 50 years were subjected to pre-operative 3-Dimensional Spiral Computerised Tomography (CT) angiography with the aim to assess its efficacy in the evaluation of renal vasculature. The investigations were carried out on a Philips Tomoscan AV Spiral CT scanner. Scan parameters included a collimation of 3 mm and table speed of 4 mm/sec. A total of 120 ml of non-ionic contrast was injected at a rate of 4 ml per second using a power injector. The axial images obtained were reconstructed at 2mm intervals and 3-D reconstruction was done using Surface Shaded Display (SSD) and Maximum Intensity Projection (MIP) protocols. CT angiography and its correlation with per-operative findings revealed 97 to 100% sensitivity and specificity in identifying the main and accessory renal arteries and veins. The angiogram also excluded the presence of pathologies like polycystic kidney, horse shoe kidney with a thick isthmus and occult renal cell carcinoma that would prevent the patient from being a donor. 3-D spiral CT angiography allows the radiologist to provide the transplant surgeon with precise pre-operative anatomy of the renal vasculature thus reducing the risks and complications associated with the harvesting procedure and increasing the chances of a successful outcome. Thus it is a fast, accurate, inexpensive and minimally invasive procedure that is becoming the modality of choice for the pre-operative evaluation of potential renal transplant donors.

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Key Words : Renal artery; Renal transplant; Spiral CT angiography

Introduction

Development of spiral CT has provided the radiologist with unparalleled capabilities to acquire high quality image data. The ability to acquire thin section images, reconstruct data at narrow interscan intervals and acquire this data in the arterial and /or venous phase are capabilities that were never thought possible a few years ago. The advancement in these new scanners is due to the ability to truly move from a 'slice scanning mode' to a 'volume acquisition mode.' A 3-D spiral CT scan is not an axial image, but a three-dimensional display of those axial images in a form that is easier and faster to understand with unique display parameters [1].

There are numerous clinical applications of 3-D spiral CT angiography and one of the commonest is evaluation of the potential renal transplant donor. The use of live renal donors and laparoscopic nephrectomy has provided tremendous advantages to the transplant surgeon, but at the same time poses additional challenges. Vascular mapping of both the arterial and venous system is a must to avoid damage to aberrant or anomalous vessels. A precise assessment of the renal pelvicalyceal system and ureters is mandatory to identify anomalies like double ureters which have a direct bearing on the transplant procedure and outcome. Spiral CT angiography provides the answer to all these challenges by providing a non-invasive, fast and accurate method to image the renal

vasculature and at the same time define the presence of pathologies like polycystic kidneys, horse shoe kidney and occult renal cell carcinoma which would be a contraindication for renal transplant [2]. The aim of this study was to assess the efficacy of 3-D spiral CT angiography in the pre-operative evaluation of potential renal donors and compare the results with surgical findings.

Material and Methods

A total of 30 potential renal donors aged between 35 and 50 years were subjected to pre-operative CT angiography for evaluation of the renal arterial and venous systems. The investigations were carried out on a Philips Tomoscan AV Spiral CT scanner with a gantry rotation period of one second. A preliminary non-contrast axial abdominal CT scan was done with 10 mm collimation to localize the volume of interest and to assess for any abnormal renal or vascular calcification.

After localization of the scan coverage, volume scanning using "predict scan technique" was done with a collimation of 3 mm, table speed of 4 mm/sec and a pitch of 1.33. A total of 120 ml of non-ionic contrast containing 350 mg of Iodine per ml was injected at a rate of 4 ml per second using a power injector. The marker for the region of interest was placed on the abdominal aorta at origin of the renal arteries and a threshold value of 180 HU was fixed, so that volume scanning commenced as soon as the density of blood reached this level. The axial images obtained were reconstructed at

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2 mm intervals and sent to a work station where 3-D reconstruction and vascular mapping were done using SSD and MIP protocols. An antero-posterior CT topogram of Kidney-Ureter-Bladder (KUB) region was obtained after an interval of 5 minutes for assessment of the renal pelvicalyceal system and ureters.

Results

A total of 30 voluntary renal donors, 22 males and 8 females, in the age group of 35 to 55 years who underwent 3D-spiral CT angiography as a pre-operative evaluation were included in the study. The results obtained from analysis of the axial images and 3-D angiograms were divided into two groups, vascular and nonvascular. The vascular findings were further sub-divided into arterial and venous and are depicted in Table-1. The non-vascular findings are given in Table-2. Since 30 patients were evaluated the total number of renal units analyzed were 60, hence n=60. Table 3 shows the comparison between 3-D spiral CT angiogram and per-operative findings. Since the subjects underwent surgery only on one side for harvesting the kidney, the total number of renal units in which the CT angiogram could be compared with the surgical findings were 30, hence n=30.

Table 1

Vascular findings n=60

	Number of cases	Percentage
Arterial		
Single artery	48	80
Accessory artery	12 (R=8 L=4)	20
Pre-hilar branching	2 (R=2 L=0)	3.33
Venous		
Retroaortic vein	1	1.67
Accessory renal veins	4 (R=2 L=2)	6.67

Table 2

Non-vascular findings n=60

Findings	Number of cases	Percentage
Renal calculus	1	1.67
Renal cyst	3	5

Table 3

Comparison of CT angiogram and surgical findings n=30

Findings	On CT angiogram	Per-operative
Single artery	26	23
Accessory arteries	4	7
Prehilar branching	2 (R=2 L=0)	Left nephrectomy done
Retroaortic renal vein	1	1
Accessory renal veins	2	2

Discussion

Potential donors for renal transplantation undergo an exhaustive pre-operative examination which includes medical assessment, laboratory testing and radiological imaging [2]. The aim of imaging in these subjects is to

delineate renal vascular anatomy, to determine if the subject is a suitable candidate for transplant and if so, to assess which kidney may be technically easier to harvest. The traditional imaging workup has consisted of two examinations, Intravenous Urography and Renal Arteriography [3]. With the advent of spiral CT it is now possible to generate angiographic images and provide 3-dimensional display of the vascular anatomy and at the same time provide sufficient information of the parenchymal abnormalities thus making it the single imaging modality in the pre-operative assessment of kidney donors.

The most important evaluation is that of the renal arteries (Fig 1&2) which included their number, location of accessory arteries if any and presence of pre-hilar branching. In the present study, out of the total of 60 kidneys evaluated, 12 had accessory arteries (Fig 3) which accounts for 20% and is comparable with other studies that report an incidence of 17-28% [4,5,6]. Identification of early pre-hilar branching is important, for it may complicate or contraindicate surgery as sufficient arterial length must be present to allow for surgical clamping and to provide a sufficient arterial trunk for vascular anastomosis. Any branch of the main renal artery arising from the proximal 1.5-2 cm is considered as a pre-hilar branch [6]. This anomaly is seen in 10-13% of renal donors [7,8]. In the present study, two subjects (6%) had pre-hilar branching of the right renal artery (Fig 4) and in both the cases the division of the renal arteries were less than 1 cm from the origin. Since the early pre-hilar branching was on the right side, it did not disqualify the subject from being a donor as

Fig. 1 : 3D CT angiography (MIP) showing single renal artery and vein

Fig. 2 : 3D CT angiography (SSD) showing single renal artery and vein

Fig. 3 : 3D CT angiography (MIP) showing accessory left renal artery

the left kidney was harvested for surgery.

Venous variants like circum-aortic and retro-aortic left renal vein are seen in 3% and 17% of healthy subjects respectively [8]. Their pre-operative identification does not constitute a contraindication for transplantation, but prevents inadvertent laceration of the vein during graft procurement which can cause increased blood loss, morbidity and prolonged operating time. In the present study, one subject had a retro-aortic left renal vein (Fig 5) amounting to 3.33% of the subjects under study. A total of 4 accessory veins were identified on CT

Fig. 4 : 3D CT angiography (MIP) showing pre-hilar branching

Fig. 5 : 3D CT angiography (SSD) showing retroaortic left renal vein

angiogram, 2 on the right and 2 on the left (Fig 6). Both the patients with left sided accessory veins underwent successful transplantation.

Among the non-vascular findings, one subject had a 4 mm calculus in the right upper pole calyx which was not detected earlier and the patient underwent a successful lithotripsy of the renal calculus prior to surgery. Three subjects had simple cortical cysts, all measuring less than 1 cm in diameter. All these subjects underwent successful transplant surgery. Delayed scout projection of the KUB region after 5 minutes of injection of contrast provided adequate visualization of the renal collecting system and the ureters. No variant anatomy was detected in the pelvicalyceal system or ureters and none was present at surgery also.

Comparison of the CT angiogram and per-operative

Fig. 6 : 3D CT angiography (SSD) showing accessory renal veins on the left side

findings revealed a 97% accuracy in the detection of renal arterial system anomalies. Only one accessory renal artery was missed on CT angiogram and this artery measured 1.7 mm in diameter as established per-operatively at the time of harvesting the kidney. On retrospective analysis of the CT angiogram the same could not be identified. Rubin et al [3] and Platt et al [4] report an accuracy of 95% and 100% respectively, in the detection of accessory arteries and in their study too, the accessory arteries missed on CT angiogram were less than 2 mm in diameter. Analysis of the venous and parenchymal findings on CT angiogram and their

comparison with per-operative findings revealed 100% accuracy. 3-D spiral CT angiography is the only imaging modality providing fast, non-invasive, inexpensive and accurate pre-operative anatomy of the renal parenchyma and vasculature. It is a suitable replacement for both, intravenous urography and conventional angiography and is thus becoming the single imaging modality of choice in the pre-operative evaluation of potential renal donors.

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From an article on stomach trouble :-

‘Doctors are beginning to accept that stomach ulcers are infectious. They are caused by a bug called Helicopter’.

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