Role of Multi - detector row CT in the diagnosis and management of Solid Renal Masses

Thesis

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ABSTRACT

Multiphasic MD row CT scan of the kidneys as a promising noninvasive technique for the assessment and characterization of different solid renal mases may replace other invasive techniques as angiography and avoid unnecessary repititive IV contrast injections. Its potential advantages in preoperative evaluation is providing accurate data regarding their positions, local infiltrations, venous involvement, renal vascular anatomy, regional lymph nodes and distant metastasis.

KEY WORDS

Multiphasic, Multidetector CT scan, Solid Renal Masses

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LIST OF ABBREVIATIONS

AML	Angiomyolipoma
AV	Arterio-venous
CMP	Corticomedullary phase
CT	Computed tomography
CTA	CT angiography
CTU	CT urography
DAS	Data acquisition system
EP	Excretory phase
EU	Excretory urography
F	Female
HU	Hounsfield unit
IVC	Inferior vena cava
IVP	Intra venous pyelography
IVU	Intra venous urography
LN (s)	Lymph node (s)
M	Male
MDCT	Multi detector row CT
MIP	Maximum intensity projection
MR or MRI	Magnetic resonance imaging
MSCT	Multislice CT
NAD	No abnormality detected
NHL	Non Hodgkin's lymphoma
NP	Nephrographic phase

PACS	Picture archiving and communication system
RCC (s)	Renal cell carcinoma (s)
ROI	Region of interest
RV	Renal vein
SC	Sickle cell
SSD	Surface shaded display
STD	Standard deviation
TCC	Transitional cell carcinoma
TSC	Tuberous sclerosis complex
US	Ultrasound
VR	Volume rendering
XGP	Xanthogranulomatous Pyelonephritis
3D	Three dimensional
2D	Two dimensional

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INTRODUCTION

The role of computed tomography (CT) in the evaluation of renal lesions is very well-known. CT is widely accepted as the preferred imaging technique for suspected renal tumors, and also has an important role in tumor staging. Benign renal processes, including cystic disease, renal infection, and benign tumors may simulate malignant renal tumors, and could be defined correctly by CT. The improvements in CT technique and increased use of cross-sectional imaging have facilitated the detection of small or previously undiagnosed renal masses. Helical CT technology further improved renal imaging with decreasing volume-averaging artifacts, eliminating respiratory misregistration artifacts and allowing image acquisition during the peak intravenous contrast enhancement. Helical CT image acquisition has also led to improved data sets available for three-dimensional imaging.

To date, the major role of three-dimensional (3D) CT imaging for renal pathology has concentrated on the non-invasive evaluation of renal artery stenosis and other renal vascular abnormalities and recently literature reveals a large number of studies that describe the use of 3D-CT imaging and 3D-CT angiography (CTA) in renal mass evaluation.

AIM OF WORK

The aim of this study was to investigate the efficacy of multiphasic CT, 3D-CT imaging, CTA and CTU in the demonstration of anatomy and characterization of nature of renal masses during the preoperative evaluation.

Gross Anatomy

An average adult kidney weighs about 160 grams. It is 12 cm in length, 6 cm in breadth and 3 cm in thickness and lies on the posterior abdominal wall in the para-vertebral gutter. The exact position of the kidneys varies with respiration and the position of the body, but they lie approximately opposite the three upper lumbar vertebrae. The left kidney lies a little higher than the right. The posterior surface of each kidney faces postero-medially and the anterior surface faces antero-laterally. Its convex border faces outward and the concave border inward. It is important to remember this oblique position when radiographs are viewed ***(Hall-Craggs, 1985)***.

The kidney and its vessels are embedded in peri-renal fat, which is thickest at the renal borders, and prolonged at the hilum into the renal sinus. Fibrous connective tissue surrounding this fat is condensed as the renal fascia (Gerota's fascia). The anterior layer of the renal fascia extends medially in front of the kidney and its vessels. The posterior layer passes medially between the kidney and the fascia on the quadratus lumborum and psoas major muscles, attaching to it at the lateral and medial borders of the psoas. It also attaches to the vertebrae and inter-vertebral discs ***(Williams et al., 1995)***.

Medially, the anterior and posterior layers do not form a well defined anatomic boundary, but fuse with the adventitia of the aorta and inferior vena cava. At the lateral renal borders, the two layers of renal fascia fuse to form the lateroconal fascia, which separates the peri-renal fat from the flank fat ***(Lee et al., 1983)***. Superiorly, the two layers of renal fascia fuse above the suprarenal gland, while, below the kidney, the two layers are not firmly adherent together ***(Williams et al., 1995)***.

At the level of the kidneys, the retroperitoneum is divided into three spaces, the anterior para-renal, the peri-renal, and the posterior para-renal spaces ***(Lee et al., 1983)***.

The anterior para-renal space extends from the posterior parietal peritoneum anteriorly, to the anterior renal fascia posteriorly. This space contains the pancreas, the duodenum, the descending and ascending colon. The anterior para-renal spaces are continuous across the midline ***(Harell, 1985)***.

The peri-renal space is bounded anteriorly by the anterior renal fascia, and posteriorly, by the posterior renal fascia. It contains a variable quantity of fat, the kidney, adrenal and the proximal ureter ***(Harell, 1985)***.

The posterior pararenal space extends from the posterior renal fascia to the fascia overlying the quadratus lumborum and the psoas muscle. It has a variable medial extent and is open laterally towards the flank. It contains no retroperitoneal organs ***(Harell, 1985)***.

Renal Structure

The cortex is the outer region. It lies immediately beneath the capsule and extends inward as the renal columns of Bertin. The cortex is about 1 cm in thickness. It is well vascularized and envelops the renal pyramids. The medulla, the inner region, is made up of several conical structures (up to 18 medullary pyramids may be present). The bases of the pyramids are located at the cortico-medullary junction and the apices extend into the hilum of the kidney as the papillae. Each papilla is "grasped" by a hollow minor calyx. The minor calyces are the branches of 3-4 major calyces, which communicate to form the renal pelvis. Urine that flows from the papillae is collected in the pelvis and passes to the bladder through the ureters ***(Hall-Craggs, 1985 and Andreoli et al., 1993)***.

Normal Renal Vascular Anatomy

Renal Arteries

In most individuals, each kidney is supplied by a single renal artery that originates from the abdominal aorta. The renal arteries typically arise from the aorta at the level of L2 below the origin of the superior mesenteric artery, with the renal vein being anterior to the renal artery. The renal arteries course anterior to the renal pelvis before they enter the medial aspect of the renal hilum. The right renal artery typically demonstrates a long downward course to the relatively inferior right kidney, traversing behind the inferior vena cava ***(Kadir S, 1991)***. Conversely the left renal artery, which arises below the right renal artery and has a more horizontal orientation, has a rather direct upward course to the superiorly positioned left kidney. Both renal arteries usually course in a slightly posterior direction because of the position of the kidneys ***(Dyer R, 1993) and (El-Galley and Keane, 2000)***.

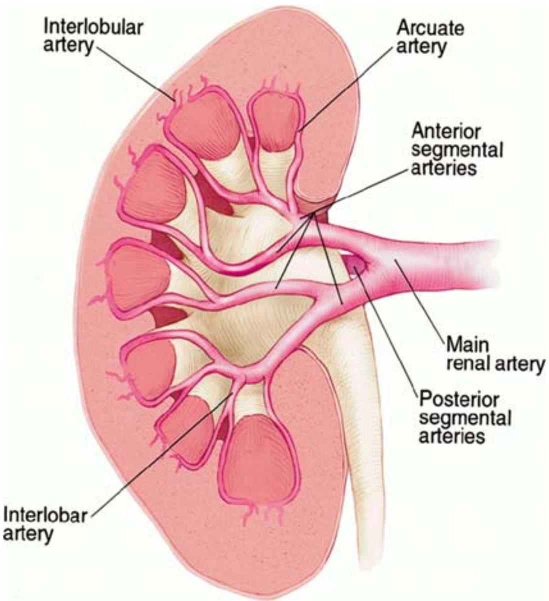

Figure 1. Renal artery ***(Bruce et al. 2001).***

The main renal artery divides into segmental arteries near the renal hilum. The first division is typically the posterior branch, which arises just before the renal hilum and passes posterior to the renal pelvis to supply a large portion of the blood flow to the posterior portion of the kidney. The main renal artery then continues before the dividing into four anterior branches at the renal hilum: the apical, upper, middle and lower anterior segmental arteries. The apical and lower anterior segmental arteries supply the anterior and posterior surfaces of the upper and lower renal poles, respectively; the upper and middle segmental arteries supply the remainder of the anterior surface. The segmental arteries then course through the renal sinus and branch into the lobar arteries. Further divisions include the interlobar, arcuate and interlobular arteries. Depiction of the relatively avascular plane between the anterior and posterior arterial divisions of the kidney is important to the surgeon, because the site can be used for a clean incision toward the renal pelvis at the time of surgery. The site is usually located posteriorly, one-third of the distance between the posterior and anterior kidney surfaces. A similar avascular plane exists between the posterior renal segment and the polar renal segments ***(Bruce et al., 2001).***

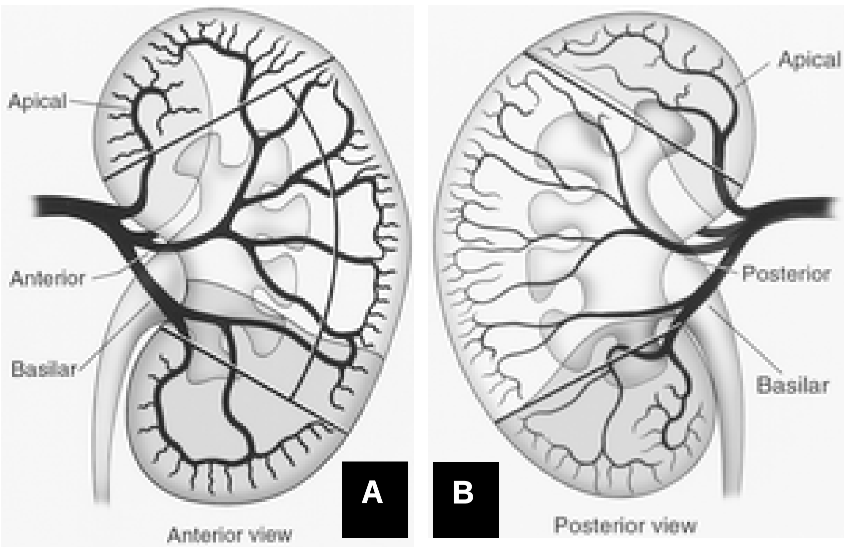

Figure 2. Normal renal segmental arterial anatomy. Drawings of the kidney from an anterior (A) and posterior (B) perspective demonstrate the apical, anterior, posterior, and basilar branches of the renal artery. ***(Deirdre et al., 2000)***

Renal veins

The renal cortex is drained sequentially by the arcuate veins and interlobar veins. The lobar veins join to form the main renal vein. The renal vein usually lies anterior to the renal artery at the renal hilum. The left renal vein is almost three times longer than the right renal vein. The left renal vein averages 6-10 cm in length and