Role of Diffusion-Weighted MR Imaging in Assessment of Renal Masses

Thesis
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Radiodiagnosis

By

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ABSTRACT

Multiple imaging modalities are used for assessment and management of renal masses. Ultrasound continues to play the initial role in diagnosis and characterization of renal masses. Refinements in techniques of Multislice CT and MRI continue to improve image quality and detectability of renal masses.

Conventional MR images potential advantages in preoperative evaluation is providing accurate data regarding their positions, local infiltrations, venous involvement, renal vascular anatomy, regional lymph nodes and distant metastases.

Magnetic resonance diffusion imaging of the kidneys as a promising noninvasive technique for the assessment and characterization of different renal masses may replace other invasive techniques as biopsy and may stop unnecessary nephrectomy for benign renal lesions.

KEY WORDS

Renal – Masses– Magnetic Resonance Imaging (MRI) – Diffusion Weighted Imaging (DWI)

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LIST OF ABBREVIATIONS

- ADC: apparent diffusion coefficient.
- ADPKD: Autosomal Dominant Polycystic Kidney Disease.
- AJCC: American Joint Committee On Cancer
- AML: Angiomyolipoma.
- ARPKD: Autosomal Recessive Polycystic Kidney Disease.
- CCSK: Clear cell sarcoma of the kidney.
- CE-MRI: Contrast enhanced Magnetic Resonance Imaging.
- CMN: Congenital Mesoblastic Nephroma.
- CT: Computed Tomography.
- DWI: Diffusion Weighted Imaging.
- EPI: Echo Planar Imaging.
- FN= False negative.
- FP= False positive.
- GRAPPA: Generalized auto calibrating partially parallel acquisition.
- HASTE: Half Fourier single-shot turbo spin echo.
- IUAC: International Union against Cancer.
- IVC: Inferior Vena Cava.
- MRI: Magnetic Resonance Imaging.
- mSENSE: modified sensitivity Encoding.
- NEX: Number of Excitations.
- NPV: Negative predictive value.
- ORTI: Ossifying renal tumor of infancy.
- PC: Plasmacytoma.
- PD: Proton Density.
- PN: Bacterial Pyelonephritis.
- PPV: Positive predictive value.
- RCC: Renal Cell carcinoma.
- RF: Radiofrequency.
- RTK: Rhabdoid Tumor of the kidney.
- ROI: Region of Interest.
- RV: Renal Vein.
- SE: Spin Echo.
- SNR: Signal to Noise ratio.
- STIR: Short time inversion recovery.

- TCC: Transitional Cell Carcinoma.
- TE: Time of Echo.
- TN: True Negative.
- TP: True Positive.
- TR: Time of Repetition.
- TS: Tuberous Sclerosis.
- UICC :Union Internationale Contre Le Cancer.
- WHO: World Health Organization.
- Xp: Xanthogranulomatous Pyelonephritis.

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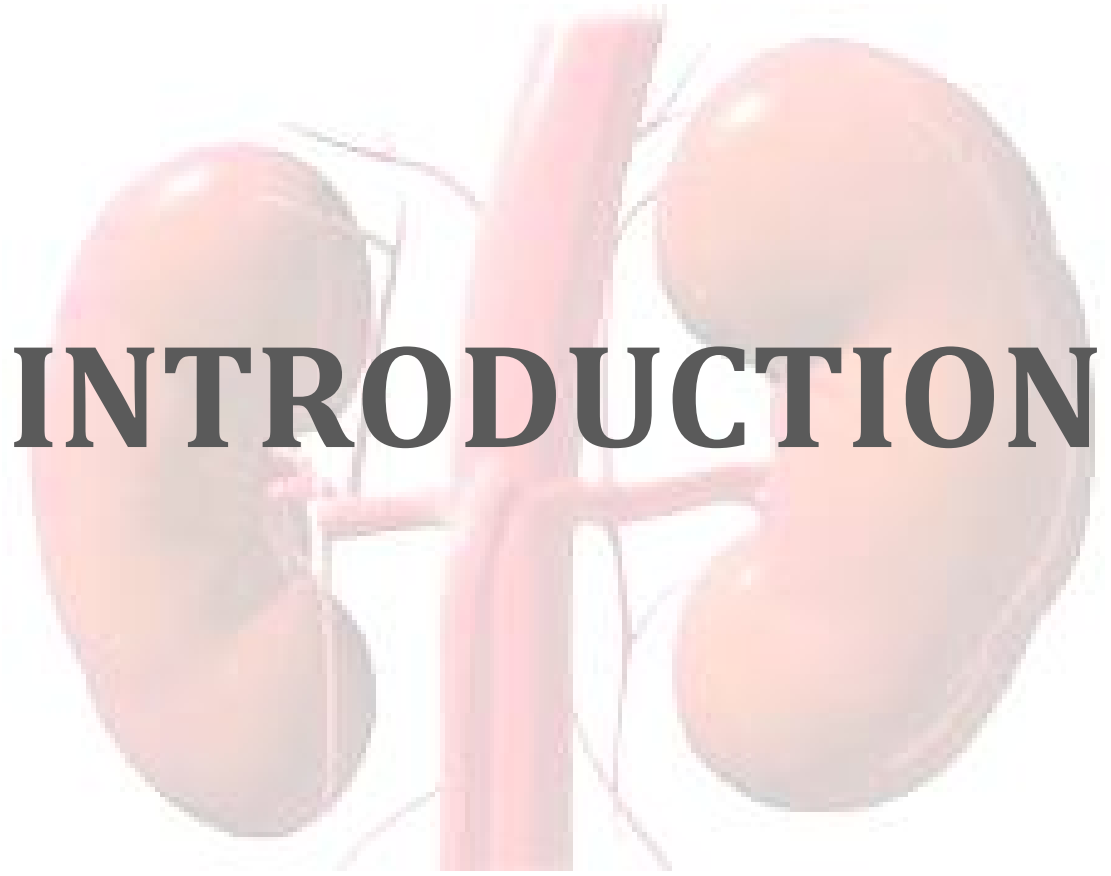

INTRODUCTION

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Renal masses are being discovered with increasing frequency due to advances of cross-sectional imaging studies being performed in clinical practice.

Accurate characterization of renal masses is essential to ensure appropriate case management, to assist in staging and prognosis and to differentiate surgical lesions from nonsurgical lesions.

In general, if a lesion cannot be characterized as benign or malignant, it should be considered malignant.

Generally, Magnetic Resonance Imaging (MRI) is performed only after a renal lesion has been detected by ultrasound or Computed Tomography (CT). MRI is still the imaging modality of choice in case of contrast allergy, functional renal impairment and pregnancy. However, MRI still requires longer examination times and has higher cost, lower availability and inferior capacity to detect lung metastasis and to provide whole-body images.

Recently, diffusion-weighted imaging (DWI) has emerged as a diagnostic technique in the evaluation of various abdominal lesions.

Application of MR DWI application to body imaging was initially limited by the inherent motion sensitivity of the technique, coupled with the presence of bulk physiologic motion in the abdomen. With use of new techniques, breath-hold diffusion-weighted imaging sequences can be appended to existing imaging protocols without a significant increase in MR imaging time.

The MR signal at diffusion-weighted imaging depends on two factors: the amplitude of random displacements of water molecules (related to the ADC value) and, to a lesser extent, the b value (degree of diffusion weighting). The b value is determined on the basis of the strength and duration of the paired gradients and the

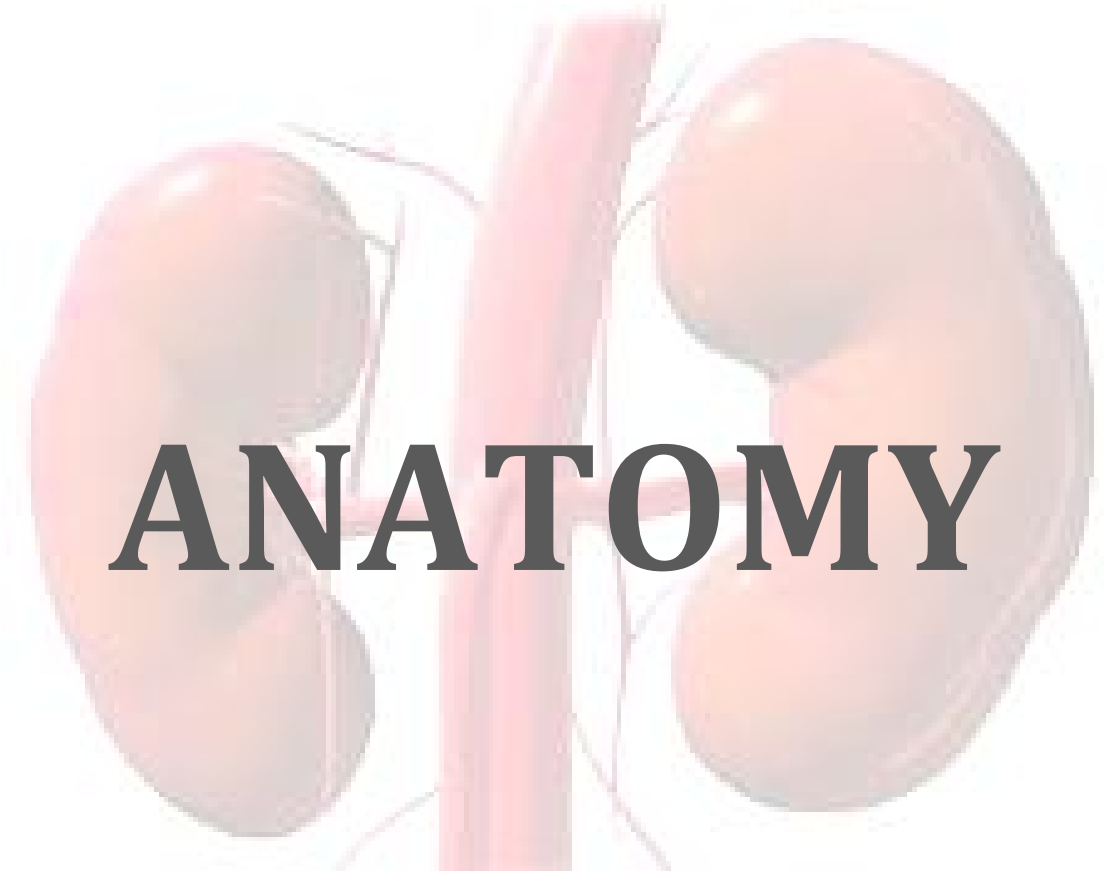
time interval between their respective applications. In clinical diffusion-weighted MR imaging, the b value is generally altered by changing the strength of the diffusion gradients.

The apparent diffusion coefficient (ADC) value has been reported to be useful for quantitatively distinguishing malignancy from benign lesions.

Diffusion-weighted MR imaging provides qualitative and quantitative tissue characterization without the need for intravenous contrast material administration and could represent a potential adjunct or alternative to contrast material–enhanced sequences in patients at risk of developing nephrogenic systemic fibrosis.

AIM OF WORK

The aim of this study is to evaluate the role of diffusion-weighted magnetic resonance imaging in assessment and characterization of renal masses, and its ability to differentiate benign from malignant renal masses.



ANATOMY

GROSS ANATOMY OF THE KIDNEYS

The kidneys are two retroperitoneal organs that are located in the peri-renal retroperitoneal space with a longitudinal diameter of 10–12 cm, 3-6 cm in breadth and 3 cm in thickness and a weight of 250–270 g. The kidney initially develops opposite to the future S2 vertebra, but eventually comes to rest opposite to L1 or L2 vertebra ***(Federle, 2006)***

The right kidney, anteriorly, has a relation with the inferior surface of the liver with peritoneal interposition, and with the second portion of the duodenum without any peritoneal interposition since the second portion of the duodenum is retroperitoneal ***(Fig. 1a). (Quaia et al., 2011)***

The left kidney, anteriorly, has a relation with the pancreatic tail, the spleen, the stomach, the ligament of Treitz and small bowel, and with the left colic flexure and left colon ***(Fig. 1a)***. ***(Quaia et al., 2011)***

Posteriorly, both kidneys present a relationship with the diaphragm, with the lateral margin of the psoas muscle, with the aponeurosis of the transverse abdominis muscle, and with the lumbar muscle ***(Fig. 1b)***. Superiorly, both kidneys have a relation with the adrenal glands, while the right kidney is separated from the inferior surface of the liver by the interposition of a double peritoneal sheet which derives from the reflection of the peritoneum to the inferior limit of the coronary liver ligament that delimitates the hepato-renal space or Morrison pouch. ***(Quaia et al., 2011)***

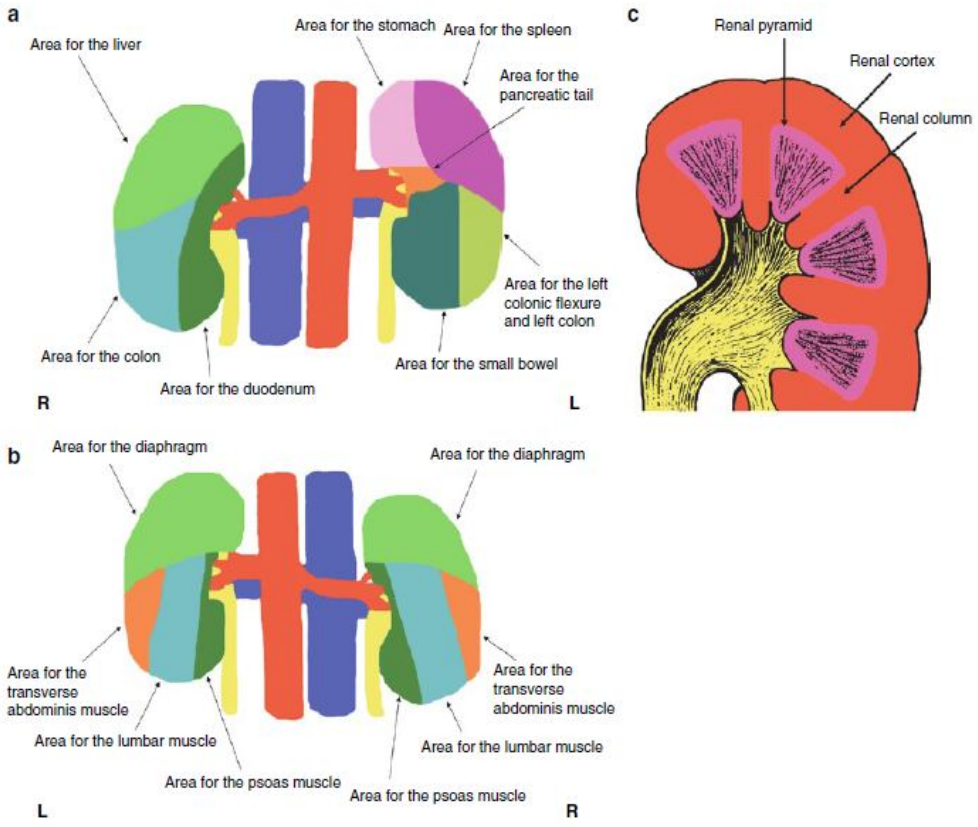


Figure 1. (**a**) Scheme of the anterior anatomical relations of the kidneys: *R* right; *L* left. (**b**) Scheme of the posterior anatomical relations of the kidneys: *R* right; *L* left. (**c**) Scheme of the main components of the renal parenchyma (renal cortex, renal columns, and renal medulla divided in multiple renal pyramids) overlied by the renal capsule (*black color*) ***(quoted from Quaia et al., 2011)***

At the level of the kidneys, the retro-peritoneum 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)***