Role of Diffusion MRI in Evaluation of Renal Masses

Essay

Submitted for partial fulfillment for Master Degree in Radiodiagnosis

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2017

سورة البقرة الآية: ٣٢

Acknowledgments

First and foremost, I feel always indebted to Allah, the Most Beneficent and Merciful. I can do nothing without Him.

I would like to express my deep thanks and appreciation to **Prof. Rania Ali Maarouf,** *Professor of Radio diagnosis, Faculty of Medicine – Ain Shams University, for her outstanding help, valuable instructions constant support and close supervision through revising each part of the work. I really have the honor to complete this work under her great supervision.*

My deep gratitude goes to **Dr. Ahmed Mohammed Mahmoud Abd Rabou,** *Lecturer of Radio diagnosis, Faculty of Medicine – Ain Shams University, for his great support, tireless guidance and meticulous supervision throughout this work.*

***Finally**, I wish to express all my feelings of love and appreciation to **my lovely family** who give me never ending support, understanding, love and care throughout my graduate study.*

Medhat Atef Abbas Morsy

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List of Abbreviations

Abbr.	Full-term
ADC	: Apparent diffusion coefficient
AJCC	: American Joint Committee on Cancer
AML	: Angiomyolipoma
AML	: angiomyolipoma
CCRCC	: Clear cell RCC
CCSK	: Clear cell sarcoma of the kidney
CMN	: Congenital Mesoblastic Nephroma
DWI	: Diffusion-weighted imaging
HASTE	: Half Founer single-shot turbo spin echo sequence
IUAC	: International Union Against Cancer
MCRCC	: Multi-locular Cystic Renal Cell Carcinoma
MRI	: Magnetic resonance imaging
PRCC	: Papillary renal cell carcinoma
RCC	: Renal cell carcinoma
RTK	: Rhabdoid Tumor of the kidney
SS-EPI	: Single shot EPI
TCC	: Transitional Cell Carcinoma
TS	: Tuberous sclerosis
WHO	: World Health Organization

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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 (MR DWI) is a promising noninvasive technique for the assessment and characterization of different renal masses that may stop unnecessary nephrectomy for benign renal lesions.

Key Words

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

Introduction

Renal cell carcinoma (RCC, also known as Hypernephroma, Grawitz tumor, renal adenocarcinoma) is a kidney cancer that originates in the lining of the proximal convoluted tubes, a part of the very small tubes in the kidney that transport waste molecules from the blood to the urine. RCC is the most common type of kidney cancer in adults, responsible for approximately 90-95% of cases ***(Curti et al., 2014).***

Epidemiological evidence supported the fact that renal cancer ranks for the 13th most common cancer in the world, with about 270,000 new cases diagnosed annually, and 116,000 people die from the disease ***(Ljungberg et al., 2011).***

In addition the most common presenting symptoms of renal cancer are as follows: flank and back pain, fatigue, anaemia, haematuria, weight loss, and so forth ***(Shepherd et al., 2013).***

However, there is consensus that MRI diffusion-weighted imaging technique plays a more important role in the differential diagnosis of benign and malignant renal tumors ***(Cova et al., 2004).***

Diffusion-weighted imaging (DWI) evaluates random movement of water molecular diffusion process in vivo, which can provide information on the spatial structure and biophysical

characteristics of tissue such as cellular structure, cellular density, microstructure, and microcirculation ***(Koh et al., 2007).***

In general, most neoplasm show restricted diffusion owing to the dense cellular packing of solid tumors and increased cell membranes per unit volume, leading to the restriction of water molecular movement and corresponding high signal intensity on DWI ***(Charles-Edwards et al., 2006).***

The degree of water molecules diffusion can be evaluated quantitatively by the apparent diffusion coefficient (ADC) value ***(Yoshikawa et al., 2006).***

As a quantitative parameter calculated from the DWI images, the ADC value can reflect the pathological changes of tissues and is very useful in the clinical diagnosis of central nervous system disease, various abdominal lesions, and especially renal disease ***(Feuerlein et al., 2009).***

The ADC value is inversely proportional to cellular density because increased cellular density limits water diffusion in the interstitial space ***(Ginat et al., 2012).***

In the past few decades, a large body of evidence has suggested that DWI with quantitative ADC measurements can act as predictor in differentiating malignant renal lesions from normal kidney and benign renal lesions ***(Inci et al., 2012).***

Thus the role of this study is to evaluate the recent role of Diffusion MRI in the evaluation of renal masses.

Aim of the Work

To illustrate the recent role of diffusion MRI in evaluation of renal masses.

Chapter 1
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).***

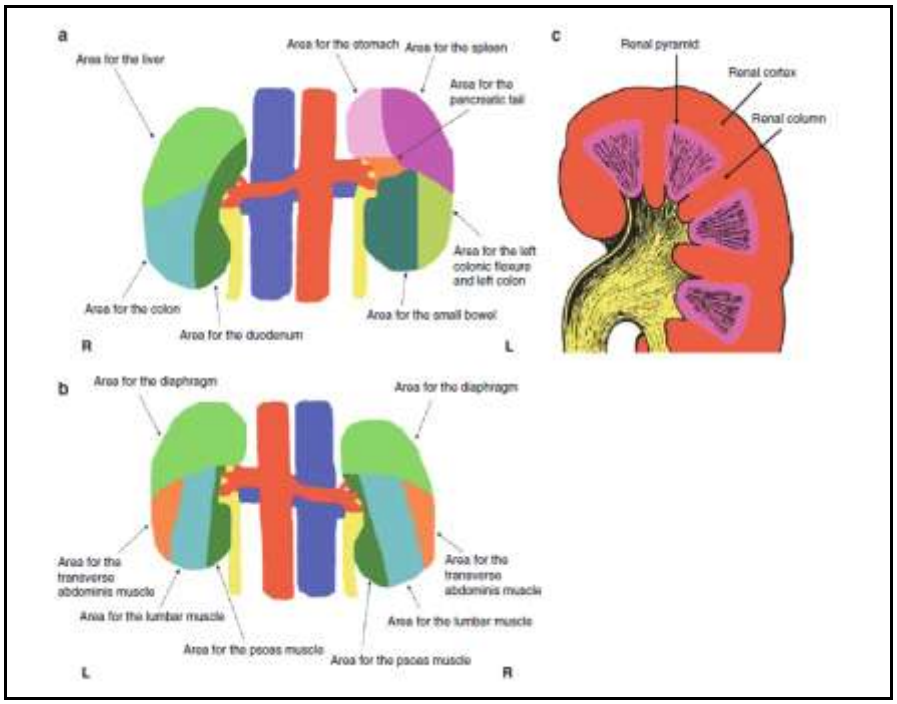

Figure (1): (**a**) Scheme of the anterior anatomical relations of the kidneys: *R* right; *L* left (**b**) Scheme of the posterior anatomical relations of the kidneys: *R* right; *L* left (**c**) Scheme of the main components of the renal parenchyma (renal cortex, renal columns, and renal medulla divided 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).***

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

Renal structure:

The renal parenchyma is composed of different components ***(Fig. 1c).*** The kidney is covered by the renal capsule formed by the fibrous and adipose renal capsule. The fibrous capsule represents the connective tissue investment of the kidney, continuous through the hilum to line the renal sinus. The adipose renal capsule represents the investment of fat surrounding the fibrous capsule of the kidney, continuous at the hilum with the fat in the renal sinus (***Quaia et al., 2011).***