Role of Contrast Enhanced Ultrasound in Differentiation between Benign and Malignant Solid Renal Masses

Essay

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First and foremost thanks to (ALLAH) Who is the Most Beneficial and Most Merciful.

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List of Abbreviations

Abbrev.	Full Term
AML	: Angiomyolipoma
AUC	:Area Under Curve
CEUS	:Contrast Enhanced Ultrasound
CCRCC	:Clear cell Renal Cell Carcinoma
ChRCC	:Chromophobe Renal Cell Carcinoma
CDUS	:Color Doppler Ultrasound
CSHI	: Contrast Specific Harmonic Ultrasound Imaging
CT	:Computed Tomography
EFSUM	:European Federation of Societies for Ultrasound in Medicine and Biology
IVC	:Inferior Vena Cava
MHZ	:Mega Hertz
MI	:Mechanical Index
MRI	:Magnetic Resonance Imaging
MTT	:Mean Transit Time
PI	:Peak Intensity
PIHI	:Pulse Inversion Harmonic Imaging
pRCC	:Papillary Renal Cell Carcinoma
PT	:Peak Time
RCC	:Renal Cell Carcinoma
ROI	:Region Of Interest
RT	:Rising Time
SRM	:Solid Renal Masses
TIC	:Time-Intensity Curves
TPH	:Time from Peak to one-Half
TTP	:Time To Peak
US	:Ultrasound
USCA	:Ultrasound Contrast Agents
WHO	: World Health Organization
WIS	:Wash-In Slope
WOS	:Wash Out Slope

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Abstract

Purpose: To discuss the evaluation of the enhancement curve over time of the major renal cell carcinoma (RCC) subtypes, oncocytoma, and lipid-poor angiomyolipoma, to aid in the preoperative differentiation of these entities.

Differentiation of these lesions is important, given the different prognoses of the subtypes, as well as the desire to avoid resecting benign lesions.

Methods: Review the literature and discuss the findings of US, but with a special emphasis on contrast-enhanced ultrasound (CEUS). CEUS technique is described, as well as time–intensity curve analysis.

Results: Examples of each of the major RCC subtypes (clear cell, papillary, and chromophobe) are shown, as well as examples of oncocytoma and lipid-poor angiomyolipoma. For each lesion, the time–intensity curve of enhancement on CEUS is reviewed.

Conclusions: Preoperative differentiation of the most common solid renal masses is important, and the time– intensity curves of these lesions show some distinguishing features that can aid in this differentiation. The use of CEUS is increasing, and as a modality it is especially well suited to the evaluation by the time–intensity curve.

Introduction

In the recent years the prevalence of renal tumors has been increased, most probably due to an increased detection by using new imaging methods. Nephrectomy or nephron-sparing partial nephrectomy is performed for these renal tumors, but as many as 30% of the lesions prove to be benign, while another 25% are low-grade malignant tumors, which generally have less metastatic potential than clear cell renal carcinoma***.(Sparchez et al, 2015)***

Most renal masses are found incidentally. From the diagnostic point of view, in the case of a focal renal lesion, the following entities must be taken into account : neoplastic, non-neoplastic lesions. ***(Ignee et a, 2010).***

B-mode ultrasound (US) can differentiate between cystic and solid renal masses but can not characterize solid tumors as benign or malignant. Color Doppler can not diagnose didorders at the level of capillaries and limited in detection of renal vein thrombosis, collecting system invasion and imaging of perfusion of cystic septations and cystic nodules. ***(Piscaglia et al, 2012).***

Contrast enhanced ultrasound (CEUS) allows real time evaluation of microvasculature. It can be performed for wide variety of indications in all parts of human body, including detection and characterization of renal lesions. The promise of CEUS is particularly significant in this regard, given its many potential advantages over the other modalities, not least among them its ability to be used in patients with renal failure. ***(Piscaglia et al, 2012).***

CEUS is a safe, accurate alternative capable of improving the diagnostic capabilities of B mode US. It provides a new imagic tool to investigate patients when CT/MRI imaging is either contraindicated or yielding equivocal finding. Guidelines recommend CEUS to: characterize cystic masses; differentiate diagnosis renal tumors and pseudo-tumors when B mode US is equivocal , diagnose renal abscesses in clinically-suspected patients with impaired renal function, and replace the standard CECT/ MRI in the follow up after focal ablation or surgery.

New application emerge such as the quantitative analysis of enhancement features of various tumors, to help the differentiation between malignant and benign tumors .***(Sparchez et al, 2015)***

After contrast injection, enhancement can be detected in real time for up to 5–7 minutes in the liver or spleen. However, kidneys enhance for a shorter period of time. The arterial pedicle and main branches pick up the agent first. After a few seconds, the cortex enhances, followed by medullary perfusion.The outer medulla fills in earlier, whilethe pyramids fill in gradually later **(*Correas, 2006*).**

The US contrast agents are composed of gas microbubbles enclosed in a protein, lipid, or polymer shell. The microbubble diameter ranges from 1 to 10 μm,which is in general the size of a red blood cell. As a consequence, these drugs show no extravascular passage and are regarded as pure blood pool agents. ***(Piscaglia et al, 2012).***

Aim of the work

The purpose of this work is to review the value of contrast enhanced ultrasound (CEUS) to differentiate between the common benign and malignant solid renal masses.

Kidneys are the most important organs of the genitourinary system and one of the most important vital organs of the body***(Eble et al, 2006).***

1. Development :

The kidneys develop from primitive excretory organs, which emerge in a cranio-caudal sequence beginning in the cervical region of the fetus at three weeks' gestation ***(Reiser et al, 2014)***.

Renal development begins at 3rd week, with a transient precursor organ called the pronephros, which is later replaced by the mesonephros at four to eight weeks' gestation.

Although most of the mesonephros degenerates, a portion develops into the mesonephric or Wolffian duct, which gives rise to the ureteric bud and male genital development.

During embryogenesis, the kidneys undergoa cephalad migration from the pelvis and a medialrotation of about 90 degree around their longitudinal axis. **(fig.1)**. ***(Isabel et al, 2013).***

The proximal ureteric bud enlarges into an ampulla, which undergoes dichotomous division to form the renal pelvis, calyces and collecting tubules of the renal medulla. This results in the development of 10 to 14 minor calyces***(Reiser et al, 2014)***.

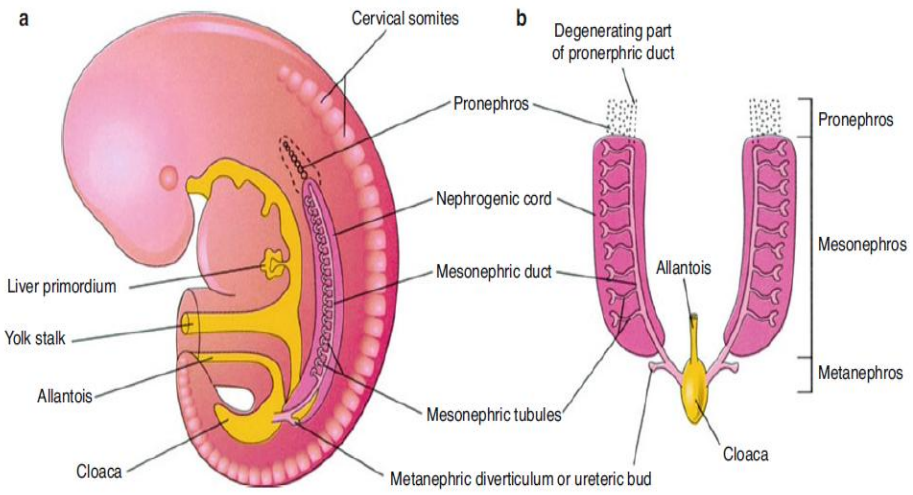
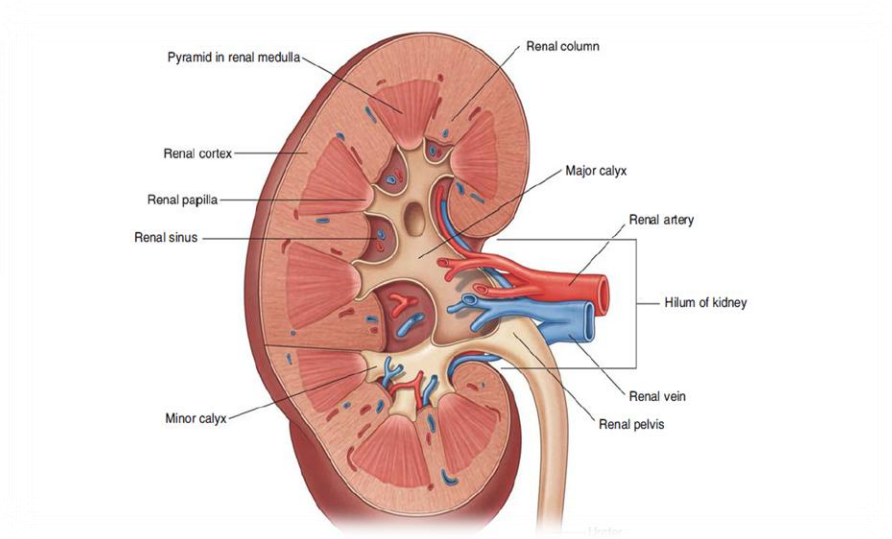


Figure (1): Diagram illustrates the three sets of excretory system***(Reiser, 2014)***

2. Anatomy

Kidneys are retroperitoneal organs, even and symmetrical, located on the sides of the spinal column, at the level of the 12th dorsal vertebra and 2nd–3rd lumbar vertebra. They are bean shaped, consisting of anterior and posterior surfaces, superior and inferior pole and lateral and medial margins. The last one contains the hilum, namely, the renal sinus which contains calyces, a portion of pelvis, main vessels and the nerves**(Fig.2)*(Olevitti et al, 2015).***

The hilum of the kidney lies medially, that of the left at L 1 vertebral level and that of the right slightly lower at L 1 /L 2 level, owing to the bulk of the liver above. At the hilum, the pelvis lies posteriorly and the renal vein anteriorly with the artery in-between.The artery may branch early and a posterior arterial branch may enter the hilum posterior to the pelvis. Lymph vessels and nerves also enter at the hilum. ***(Ryan et al, 2011).***



Figure(2): Internal structure of the kidney (**Sarah ,2011**).

Relations

The kidneys are retroperitoneal and related to the psoas muscles medially. They are surrounded by perirenal fat and confined by the anterior and posterior perirenal fascia, known as Gerota's fascia and Zuckerkandl's fascia, respectively**.(Fig.3)** The fascia separates the perirenal space from the remaining retroperitoneum, limiting spread of inflammation and infection between the compartments. Morrison's pouch or the hepatorenal fossa, a continuation of the peritoneal cavity, lies between the right kidney and the liver ***(Sarah and Adam, 2011).***

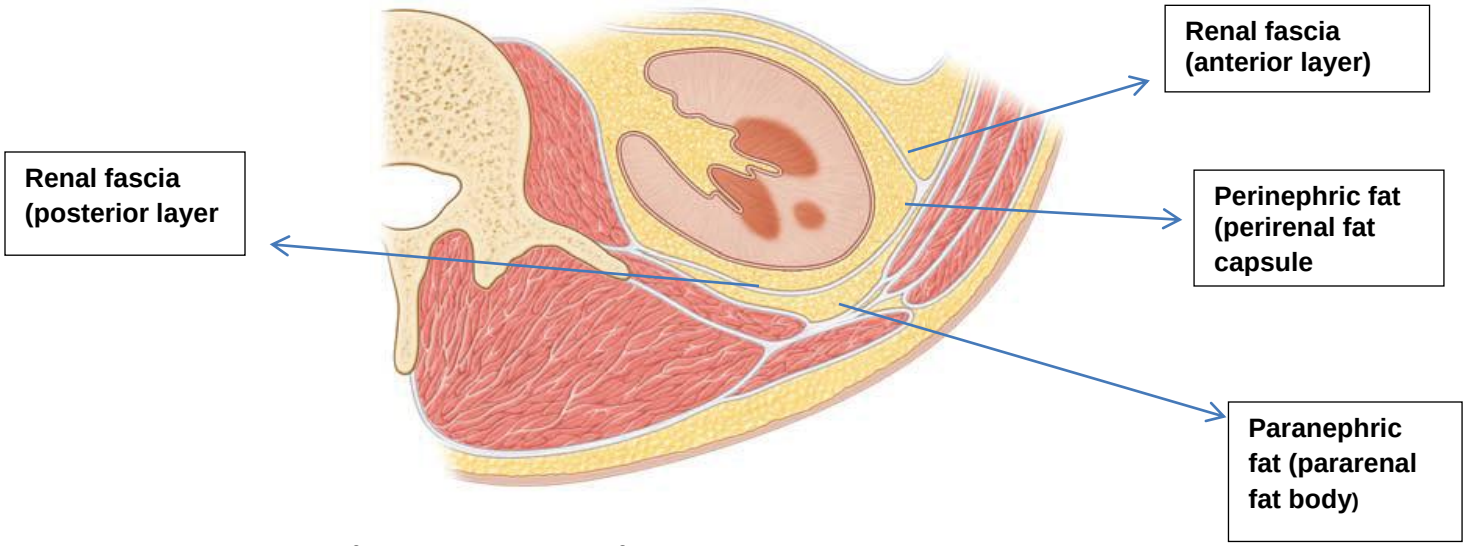


Figure (3): Musculofacial relationships of kidneys.***(Moore et al, 2015).***

The upper pole of the kidney is more medial and posterior than the lower pole of the kidney. **(Fig .4)*(Sarah and Adam , 2011).***

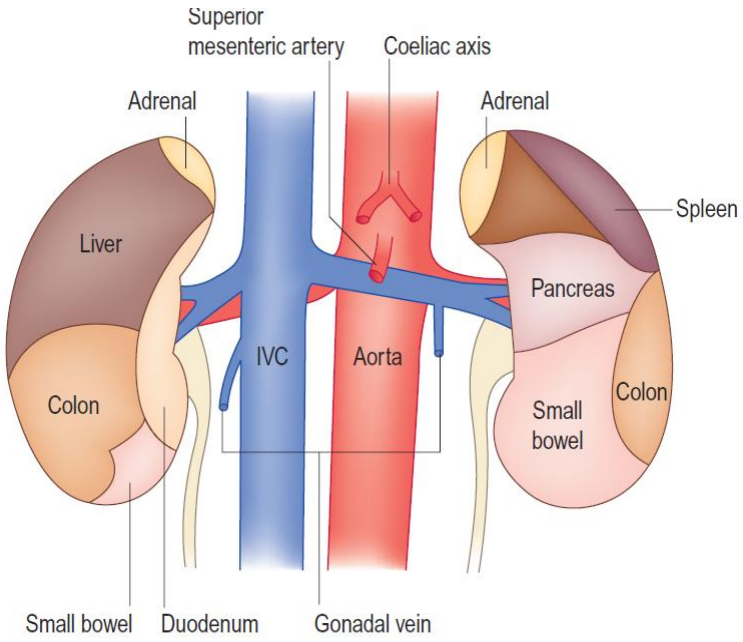


Figure (4): Anatomical relations of the kidneys**. *(Moore, 2015*)**