APPLICATIONS OF DUAL - ENERGY CT IN DISEASES OF THE URINARY SYSTEM

An Essay

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Radiodiagnosis

By

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وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ
عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ

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LIST OF ABBREVIATIONS

Abbreviation	Name
CM	Contrast Material
CT	Computed Tomography
DE	Dual Energy
ESWL	Extracorporeal Shock Wave Lithotripsy
Fig.	Figure
FOV	Field of View
HIV	Human Immunodeficiency Virus
HU	Hounsfield Units
IV	Intra Venous
keV	Kilo Electron Volt
KUB =	Kidney, Ureter, Bladder
kV	Kilo Voltage
kVp	Peak Kilo Voltage
mAs	Milli Ampere
MDCT	Multi Detector Computed Tomography
MIP	Maximum Intensity Projection
MPR	Multi Planar Reconstruction
PCNL	Percutaneous Nephrolithotomy
SWL	Shock Wave Lithotripsy
UA	Uric Acid
VC	Virtual Contrast
VNC	Virtual Non Contract

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INTRODUCTION

Changes are occurring in medical CT that promises to augment the already well-recognized CT strengths of speed, high resolution, excellent patient tolerance, and large territory coverage. These changes include dose reduction, noise reduction, and more speed. But perhaps more fundamentally, the ability to perform dual-energy scanning at CT is being developed by every major CT scanner manufacturer and provides the ability for CT to differentiate between different materials at imaging. Dual-energy CT improves our ability to detect contrast material and distinguish the high-density areas created by iodine from those created by calcium or other substances—in essence, dual-energy CT brings the insight of tissue and material decomposition to standard gray-scale CT images ***(Yeh et al, ٢٠٠٩).***

Dual-energy CT provides information about how substances behave at different energies, the ability to generate virtual unenhanced datasets, and improved detection of iodine-containing substances on low-energy images.

Knowing how a substance behaves at two different energies can provide information about tissue composition beyond that obtainable with single-energy techniques ***(Coursey et al, ٢٠١٠).***

Several promising clinical applications for dual-energy computed tomography (CT) in genitourinary imaging have been reported. Dual-energy CT not only provides excellent morphologic detail but also can supply material-specific and quantitative information that may be particularly useful in

genitourinary imaging. Dual-energy CT has unique capabilities for characterizing renal lesions by quantifying iodine content and helping identify the mineral contents of renal stones, information that is important for patient care and therapeutic decision making ***(Kaza et al , ٢٠١٢).***

Since the early ١٩٩٠s, the use of unenhanced CT has gained widespread acceptance in the evaluation of nephrolithiasis. Because studies have shown that helical CT can depict urinary stones more precisely than do radiography , sonography , nephrotomography , and excretory urography , MDCT has become the technique most used for rapid and accurate determination of the presence of stones in evaluations for urinary lithiasis treatment.

Precise determination of the symptoms, localization, size, and chemical composition of stones is the key to diagnosis and choice of therapy ***(Grosjean et al, ٢٠٠٨).***

Dual Energy multidetector CT with advanced postprocessing techniques improves characterization of renal stone composition beyond that achieved with single-energy multidetector CT acquisitions with basic attenuation assessment ***(Boll et al, ٢٠٠٩).***

So dual-energy CT will play an expanded role in the evaluation of patients with genitourinary disease in the future by providing expanded diagnostic information from CT images. Material characterization and diagnostic accuracy will be improved using dual energy CT ***(Vrtiska et al, ٢٠١٠).***

AIM OF THE WORK

The aim of this work is to illustrate the role of dual energy multidetector CT in assessment of urinary diseases, mainly urinary stones.

CHAPTER ١

ANATOMY OF THE URINARY SYSTEM

THE KIDNEYS:

The bean-shaped kidneys are retroperitoneal in the posterior abdominal region. They lie in the extra peritoneal connective tissue immediately lateral to the vertebral column. In the supine position, the kidneys extend from approximately vertebra T١٢ superiorly to vertebra L٣ inferiorly, with the right kidney somewhat lower than the left because of its relationship with the liver. Although they are similar in size and shape, the left kidney is a longer and more slender organ than the right kidney, and nearer to the midline (fig. ١) ***(Drake et al., ٢٠٠٧).***

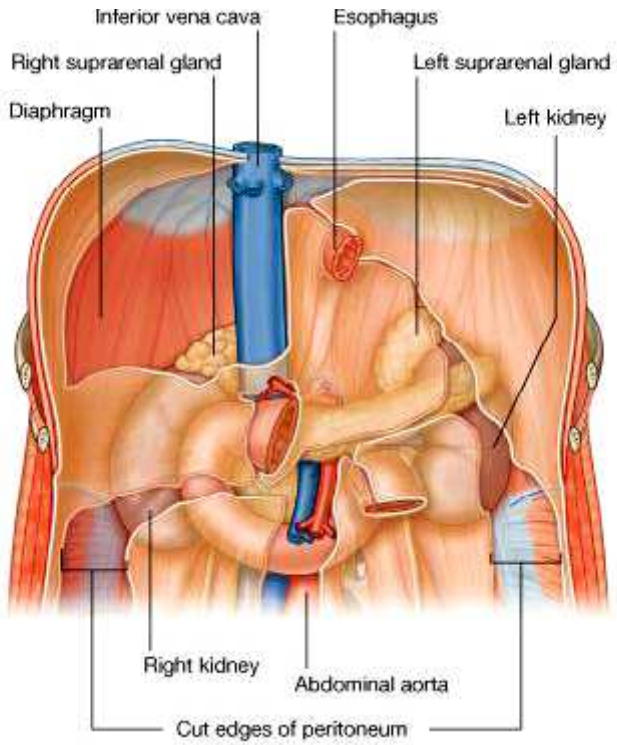

Figure ١،١: *Retroperitoneal position of the kidneys in the posterior abdominal region* ***(quoted from Drake et al.,٢٠٠٧).***

The renal parenchyma is divided into outer lighter cortex and inner darker medulla (fig. ٢). The medulla is composed of multiple, distinct, conically shaped areas termed renal pyramids, the apices of which are called renal papillae. Each papilla is cupped by an individual minor calyx. The sharp edged portion of each minor calyx extending around the papilla is called the calyceal fornix.

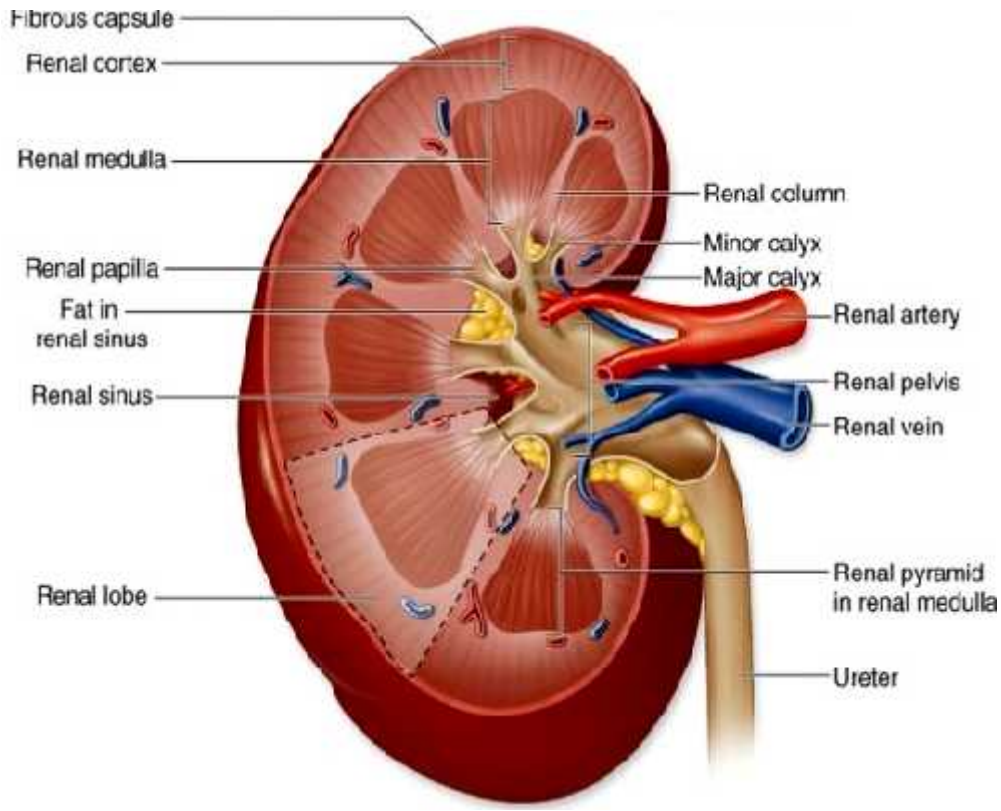

Figure ١،٢: *Internal structure of the kidney* ***(quoted From Yaqoob, ٢٠٠٩).***

The renal cortex is ١،٢ to ١،٥ cm in thickness, and not only covers the renal pyramids peripherally but also extends between the pyramids themselves forming the columns of Bertin. Through these columns renal vessels traverse from the renal sinus to peripheral cortex. So percutaneous access to the collecting system is made through a renal pyramid thus avoiding the columns of Bertin ***(Anderson et al., ٢٠٠٧).***

On the medial margin of each kidney is the hilum which is a deep vertical slit through which renal vessels, lymphatics, and nerves enter and leave the substance of the kidney. Internally, the hilum is continuous with the renal sinus. Perinephric fat continues into the hilum and sinus and surrounds all structures **(*Drake et al., ٢٠٠٧*).**