Effect of Stone Hounsfield Units Measured By Multidetector Computed Tomography on The Stone Disintegration After Extra Corporeal Shock Waves Lithotripsy For Renal Stones

Prospective Study

Thesis

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Tarek Salem Rezk Rezk

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿ وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ

فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا ﴾

صدق الله العظيم

سورة النساء آية (١١٣)

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List of Abbreviations

Abb.	Full term
BMI	Body mass Index
CT	Computed Tomography
ECIRS	Endoscopic combined Intrarenal surgery
ESWL	Extra corporeal shockwave Lithotripsy
HU	Hounsfield Units
MDCT	Multidetector computed Tomography
MRI	Magnetic resonance imaging
PCNL	Percutaneous nephrolithotripsy
RIRS	Retrograde intrarenal surgery
SFR	Stone free rate
SSD	Stone skin distance

Abstract

Attenuation value of renal stones was measured by CT in terms of Hounsfield units. The relation between Hounsfield units and stone disintegration (measured by number of ESWL sessions) as follows. Up to 970 HU(16 patients),most stones disintegrated after 2 sessions. P value 0.002 and correlation coefficient 0.532 which means statistically significant correlation between HU and stone disintegration (no. Of ESWL sessions).As Hounsfield units increase, the number of ESWL sessions increase and consequently stone disintegration. Taking into consideration that stone free rate is related to other factors including skin to stone distance, site and size of stone.

ESWL results were affected by stone site. The clearance rate of stones located in the pelvis is higher than those located in the calyces. The clearance rate for upper pole stones is faster than for stones in the lower pole.

Key words: Computed Tomography- Hounsfield Units- Stone free rate-Percutaneous nephrolithotripsy Multidetector computed Tomography

INTRODUCTION

It is found that nephrolithiasis is increasing in its incidence especially in middle east countries. This increase is not related to factors like age, sex and race. The most important risk factors include obesity, decreased fluid and calcium consumption, increased sodium, oxalate and animal protein consumption.(1)

Before introduction of shock wave lithotripsy (ESWL) to clinical practice in 1980, most of stones were removed by open surgery with potential risk of complications and prolonged post operative stay. As stone disease is recurrent, stone formers often underwent multiple, highly invasive surgeries over time. SWL offered an entirely non invasive means to remove stones and eliminate any stones without injury to the kidney.(2)

Recently, non-contrast-enhanced computed tomography (CT) has become the imaging of choice for diagnosis of urolithiasis because of its high sensitivity and specificity and its ability to detect radiolucent stones.(3)

Hounsfield units (HU), a parameter generated from standard CT, are related to the density of the stone or structure of interest.(4)

Sir Godfrey Newbold Hounsfield was the first to introduce the principle of quantifying the amount of X rays passing through or absorbed by tissues, and developed the resulting radiodensity scale. Hounsfield units (HU) have been used to evaluate and quantify tissues and fluids. Using this method it is possible to differentiate 256 shades of gray that are indistinguishable to the naked eye. This accurate method adds to the efficiency of CT as method for diagnosis and follow up for urolithiasis management.(5)

Aim of the Work

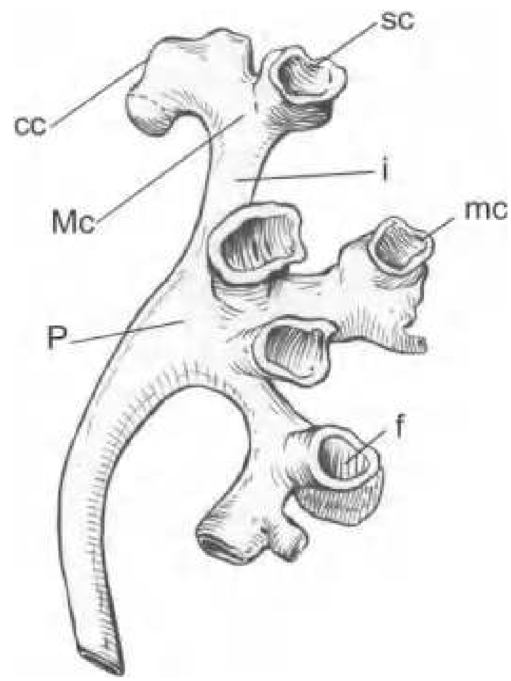
To illustrate the efficiency of measuring stone Hounsfield units by CT in predicting stone disintegration post ESWL for renal stones.

Chapter One

ENDOUROLOGICAL ANATOMY OF THE KIDNEY

Renal parenchyma basically consists of two kinds of tissue the cortex and medulla. The cortical tissue is made up of the glomeruli with proximal and distal convoluted tubules. The renal pyramids are made up of loops of Henle and collecting ducts; these ducts join to form the papillary ducts (about20), which open at the papillary surface and drain urine into the collecting system. A minor calyx is defined as the calyx that is in immediate relation to a papilla. The renal minor calyces drain the renal papillae and range in number from 5 to 14 (mean, 8); we have found 70% of kidneys to have 7–9 minor calyces. A minor calyx may be single (drains one papilla) or compound (drains two or three papillae). The minor calyces may drain straight into an infundibulum or join to form major calyces, which subsequently will drain into an infundibulum. Finally, the infundibula, which are considered the primary divisions of the pelvicalyceal system, drain into the renal pelvis (figure 1). (6)

A



B

Figure (1): (A) Anterior view of a pelvicalyceal endocast from a left kidney, obtained according to the injection–corrosion technique. (B) Schematic of the endocast shown in A. This shows the essential elements of the kidney collecting system. cc, compound calyx; sc, single calyx; mc,minor calyx; Mc, major calyx; f, calyceal fornix; i, infundibulum; P,renal pelvis. (7)

Generally, the main renal artery divides into an anterior and a posterior branch after giving the inferior suprarenal artery. The posterior branch proceeds as the posterior segmental artery to supply the corresponding segment without further significant branching, the anterior branch of the renal artery provides three or four segmental arteries. The segmental arteries divide before entering the renal parenchyma into the interlobar arteries (infundibular arteries), which progress adjacent to the calyceal infundibula and the minor calyces, entering the renal columns between the renal pyramids. As the interlobar arteries progress, near the base of the pyramids, they give origin (usually by dichotomous division) to the arcuate arteries. The arcuate arteries give off the interlobular arteries, which run to the periphery, giving off the afferent arterioles of the glomeruli (figure 2).(8)

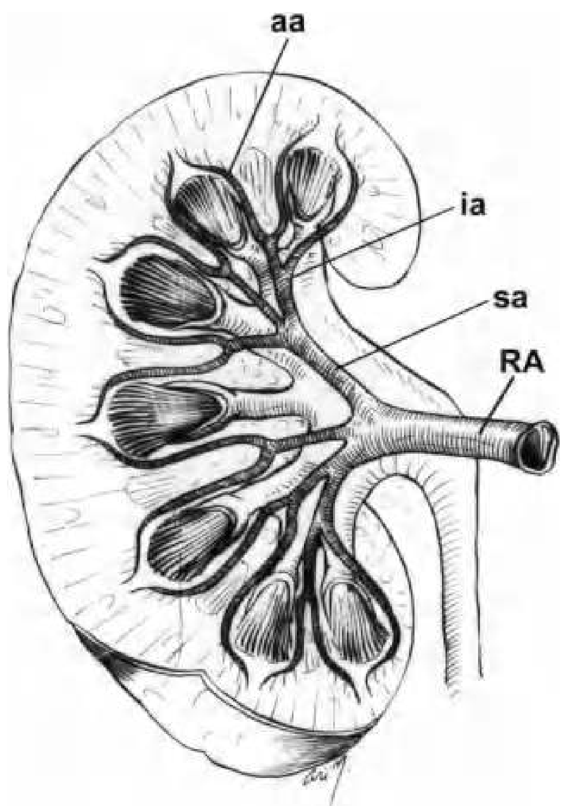


Figure (2): Schematic of an anterior view of a right kidney. This shows the branching of the renal arteries and their official nomenclature according to kidney region RA, renal artery; sa, segmental artery; ia, interlobar (infundibular) artery; aa, arcuate artery. (9)

The intrarenal veins, unlike the arteries, do not have a segmental model. Moreover, unlike the arteries, there is free circulation throughout the venous system, with abundant anastomoses between the veins. These anastomoses, therefore, prevent parenchymal congestion and ischemia in case of venous injury.(10)

The kidneys lie on the psoas and quadratus lumborum muscles. Usually, the left kidney is higher than the right kidney, with the posterior surface of the right kidney crossed by the 12th rib and the left kidney crossed by the 11th and 12th ribs. The posterior surface of the diaphragm attaches to the extremities of the 11th and 12th ribs. Close to the spine, the diaphragm attached over the posterior abdominal muscles, and forms the medial and lateral arcuate ligaments on each side. In this way, the posterior aspect of the diaphragm arches in a dome above the superior pole of the kidneys, on each side (figure 3).