Ultrasound guided Extracorporeal Shock Wave Lithotripsy (SONO ESWL) versus fluoroscopy guided ESWL in patients with radiopaque renal stones

Thesis

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بسم الله الرحمن الرحيم

﴿وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ
فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا﴾

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Dedication

Words can never express my sincere thanks to ***My Family and My Wife*** *for their generous emotional support and continuous encouragement, which brought the best out of me. I owe them all every achievement throughout my life.*

I would like to express my everlasting gratitude to all ***My Professors, Colleagues and Friends****, so many of them influenced, encouraged and inspired me throughout the years. I wish them the best of all.*

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List of Abbreviations

Abb.	Full term
AIUM	American Institute for Ultrasound in Medicine
AUA	American Urological Association
BMI	Body Mass Index
CBC	Complete blood count
CT	Computed tomography
EAU	European Association of Urology
ESWL	Extracorporeal shockwave lithotripsy
Gy	Gray
HU	Hounsfield units
IR	Ionizing radiation
KUB	Kidney-ureter-bladder
mSv	MilliSieverts
NSAIDS	Nonsteroidal anti-inflammatory drugs
PCNL	Percutaneous nephrolithotomy
RRL	Relative radiation level
SFRs	Stone free rate
SSD	Skin-to-stone distance
Sv	Sieverts
U/S	Ultrasound

INTRODUCTION

Incidence of nephrolithiasis is escalating 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 intake and calcium consumption, increased sodium, oxalate and animal protein consumption.(1)

There are many options for treatment of renal stones and the choice is dependent on many factors including patient age and comorbidity, stone factors (size, type, site), anatomy of the kidney, and sometimes patient's preference.(2) These options include oral chemical dissolution, extracorporeal shock wave lithotripsy, percutaneous nephrolithotripsy, retrograde intrarenal lithotripsy or open surgery.(3)

Currently, there is a trend towards the utilization of minimally invasive endoscopic procedures, for example, (flexible) ureteroscopy or mini percutaneous nephrolithotomy for the treatment of renal stones. Despite of this development, ESWL stays one of the preferred treatment options for renal stones<20 mm.(4) ESWL has a low complication rate and does not require general anaesthesia.(5)

The success rate of ESWL is affected by stone factors (stone size, location, composition, degree of obstruction), clinical factors (comorbidities for example, concomitant infection, abnormal ureteral anatomy), and technical factors (available equipment, source of energy).[6] several factors impacting the stone clearance and success rate, such as body mass index and skin-to-stone distance.[7]

The initial extracorporeal shockwave lithotripsy (ESWL) machines used fluoroscopy for stone localization and treatment monitoring. Although this imaging method has the benefit of being familiar to urologists, it has some drawbacks, such as difficulty in localizing some stones, especially radiolucent stones, and exposure to radiation to the operator and the patient.[8]

Ultrasound is ideal for imaging of renal calculi during extracorporeal shock wave lithotripsy. Ultrasound can localise radiolucent stones and monitor stones fragmantation in real time. The utilization of ultrasound specifically reduces the radiation exposure to the patient and the operator, which is particularly desirable in children.[9]

Aim of the Work

This prospective randomized comparative study was done to investigate whether the localization modality (u/s or fluoroscopy) affects clinical outcomes of ESWL or not.

Chapter 1

RADIOLOGICAL 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); it was found that 70% of kidneys have 7–9 minor calyces. The 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 infundibulae, which are considered the primary divisions of the pelvicalyceal system, drain into the renal pelvis (figure 1). [10]

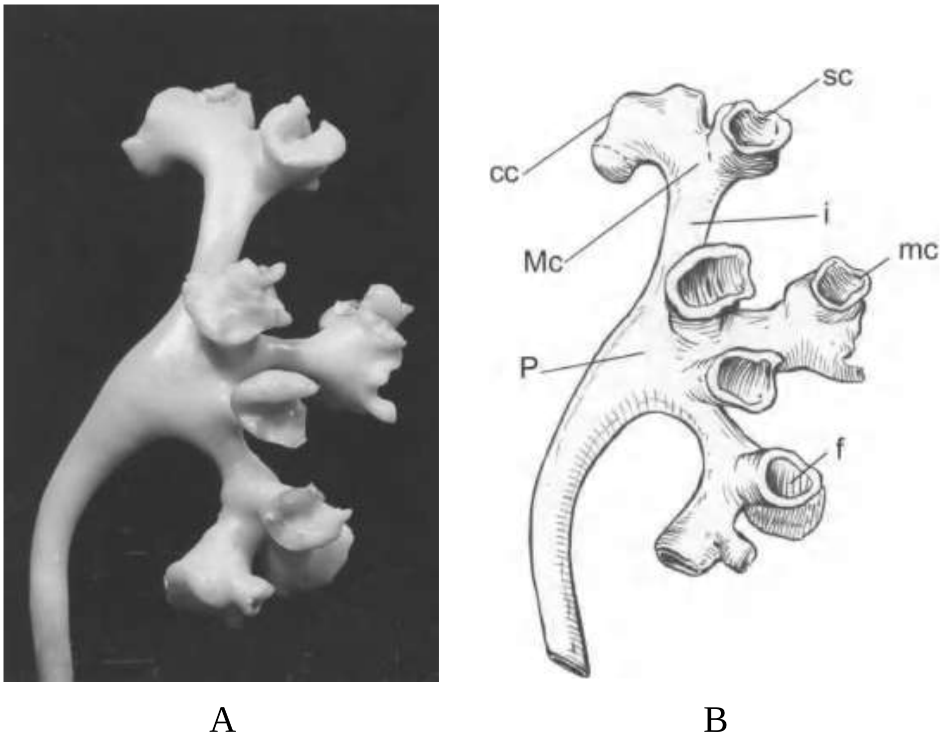

Figure (1): (A) Anterior view of a pelvicalyceal endocast from a left kidney, obtained according to the injection–corrosion technique. (B) Schematic of the endocast shown in A. This shows the essential elements of the kidney collecting system. cc, compound calyx; sc, single calyx; mc,minor calyx; Mc, major calyx; f, calyceal fornix; i, infundibulum; P,renal pelvis. (11)

- ***Radiologic Anatomy of the Renal Parenchyma***

In a well-prepared plain kidney-ureter-bladder (KUB) radiograph, the renal shape, margins, dimensions, and location can be identified. The psoas muscle line could also be appreciated. Radio-opacities, calcifications, and radiolucencies could be identified. Normally the kidney is located between the transverse processes of T12-L3 vertebrae, with the right kidney 2 centimeters (cm) lower than the left. The long axis of the kidneys is directed downwards and outwards, parallel to the lateral border of psoas muscle. The upper poles are normally oriented more medially and posteriorly than the lower poles.[12]

In gray-scale ultrasonography, the renal cortices of newborn kidneys are isoechoic or hyperechoic to the liver and splenic parenchyma, because of the presence of loops of Henle and proportionately greater volume of glomeruli in the cortex than in adults [13]. In adults, the normal kidneys have smooth margins and both renal cortices and pyramids are usually hypoechoic to the liver. Compared with renal parenchyma, the renal sinus appears hyperechoic because of the presence of hilar adipose tissue, blood vessels, and lymphatics.[14]

On unenhanced computed tomography (CT), the renal parenchyma is homogeneous, with a density ranging from 30 to 60 Hounsfield units (HU) that increases up to 80 to 120 HU after intravenous contrast injection. [15]

- ***Radiologic Anatomy of the Collecting System***

a) Excretory Urography

After an iodinated contrast agent is injected for intravenous urography, nephrotomograms appear after 60 to 90 seconds that represent contrast material within the renal tubules. Fifteen minutes after contrast injection, a panoramic radiograph of the whole urinary tract can be obtained; the bladder finally appears 20 to 30 minutes after contrast injection.