Percutaneous Nephrolithotomy Versus Non Stented Extracorporeal Shock Wave Lithotripsy for Medium Sized Kidney Stones

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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Dedication

My true love and warmest gratitude go last but not by any means least, to My Parents and all my family asking God to keep them always in a good health.

To My Wife who represents the entire world for me and always inspires me, asking God to bless her.

To My Beloved Children ***Eyad, Layan and Danna****, who I love most, hope the best in their life.*

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Introduction

Nephrolithiasis is a common complex disease.it is the third most common disaster of the urinary tract, exceeded only by urinary tract infections and pathologic conditions of the prostate. About 50 % of recurrent stone formers have just one life time recurrence (1).

Estimates of the incidence of first kidney stones between the ages of 30 and 70 years vary between approximately 100–300/100,000/year in men and 50–100/100,000/year in women. Overall, the prevalence of kidney stones is approximately 6–9% in men and 3–4% in women and this appears to be increasing (2).

Unlike appendicitis and other surgical conditions, surgical treatment of stones is not the endpoint of the disease process, as stones are likely to recur, with at least 50% of individuals experiencing another stone within 10 years of the first occurrence (3).

Shock wave lithotripsy (ESWL) is a technique using sound waves to break a kidney stone without an incision. It has been the standard therapy recommended for most kidney stones since its arrival in the early 1980s primarily because of its noninvasive nature and relatively good outcomes. Newer-generation lithotripters have been designed to cause fewer traumas to the renal unit than earlier devices (4).

Early reports enthusiastically promoted this new technology and ESWL found application in even complex cases such as multiple stones, bilateral stones, stones in solitary kidneys and staghorn calculi[5,6,7].

Many studies have shown that over the past decade, ESWL for upper tract stones has increased; Bhojani and Lingeman, 2013 claimed it increased by 55 % most of this increase (69% increase) was caused by ESWL performed on kidney stones [8], ***Pearle et al., (2005)*** reported that ESWL accounts for only 49-54% of stone removal procedures [9], Kerb et al.2002 claimed that ESWL quickly became the treatment of choice for more than 80 % of patients with urinary stones because of its minimally invasiveness compared with traditionally stone treatments While more recent study as Acland et al., 2006 concluded that there was a proportional decline over the last 4 years in both percutaneous nephrolithotomy (PNL) (12.9% -7.1 %) and ESWL (33% -23 %) with significant rise (54.1%) in the numbers of rigid and flexibe ureteroscopies (fURS) [10].

Since its introduction in 1976, percutaneous nephrolithotomy (PNL) has evolved considerably as a result of continued search for improvement in technology and surgical skills toward minimizing postoperative pain and morbidity[11].

Given this high incidence and recurrence, technological advances have been made to dramatically improve minimally invasive techniques for the management of kidney stones, such as percutaneous nephrolithotomy (PNL), extracorporeal shock wave lithotripsy (ESWL), and retrograde intrarenal surgery (RIRS) [12].

Advancements are being made in the area of preoperative imaging in an attempt to gain preoperative knowledge of stone type, which would limit unnecessary ESWL treatment. It has long been suggested X-ray attenuation values may be useful in predicting fragility. Thus, ignoring composition and focusing on stone durility (i.e. density as determined by Hounsfield Unit (HU), a term coined by ***(Dretler, 1988***) may be of greater predicitive value [13].

Percutaneous Nephrolithotomy (PNL) is the standard therapy for larger stones. PNL is currently recommended by the AUA Guidelines for management of stones more than 20 mm. Both the technologic advancement of instruments used for PNL and the advanced skill of the current endourologists have allowed PNL to become a much less complicated procedure. This increased effectiveness and safety of PNL allow it to be a more definitive treatment option with a more similar safety profile to ESWL than previously seen [14].

Aim of the Work

This prospective randomized clinical study aims at comparing the effectiveness of PNL Vs. ESWL in management of non-lower polar medium sized renal stones as regards to stone size, stone location, stone number.

Chapter (1):

Nephrolithiasis Imaging

Clinicians in a range of medical specialties will encounter patients with kidney stones. As many as one in 11 Americans develop nephrolithiasis, and over the past 15 years the prevalence has increased by almost 70% [15, 16].

Imaging of patients presenting with suspected kidney stones facilitates diagnosis and provides the first step in management by establishing the size and location of stones [18].

Symptomatology

Patients presenting to the emergency department with flank pain and haematuria are likely to undergo abdominal imaging as part of a workup for kidney stones [19], stones are largely asymptomatic when they are growing in the renal calyces. Passage into the ureter obstructs the flow of urine, leading to upstream dilatation of the ureter and renal pelvis. This obstruction generally results in colic-type pain as ureteral peristalsis increases [20].

Nausea and vomiting are often associated with these severe bouts of pain. Classically, a stone obstructs proximally near the ureteropelvic junction where the renal pelvis narrows to the calibre of the ureter. Obstruction at this point causes pain radiating to the flank. Upon presentation to the emergency department the majority of patients have stones located at the ureteropelvic junction[21], resulting in visible or microscopic haematuria. The emergency department is a common setting for the initial presentation of patients with obstructing stones [17].

1- Guidelines for imaging modalities

Stone patients are exposed to significant amounts of radiation from diagnostic imaging, primarily NCCT and fluoroscopy [24].

US should be considered the first line modality for the evaluation of stones in pediatric patients and pregnant women. The use of MRI has also been reported for the evaluation of renal colic in pregnant women. The combination of US and KUB has been shown to have high sensitivity and exposes patients to less radiation than an NCCT [25].

EAU (European Association of Urology) and AUA (American Association of Urology) guidelines [26] recommend "low-dose" NCCT as the initial imaging modality for a patient with flank pain and a suspected stone if the body mass index (BMI) in kg/m^2 is less than 30 and a standard dose NCCT if the patient is obese. Both AUA and EAU recommend a KUB concurrently with the NCCT if the stone is not seen on the scout image. For follow up of radio-opaque stones, they recommend follow-up imaging with NCCT [27] and recommend US during pregnancy and in children, with KUB or NCCT reserved if US does not provide the required information [28].

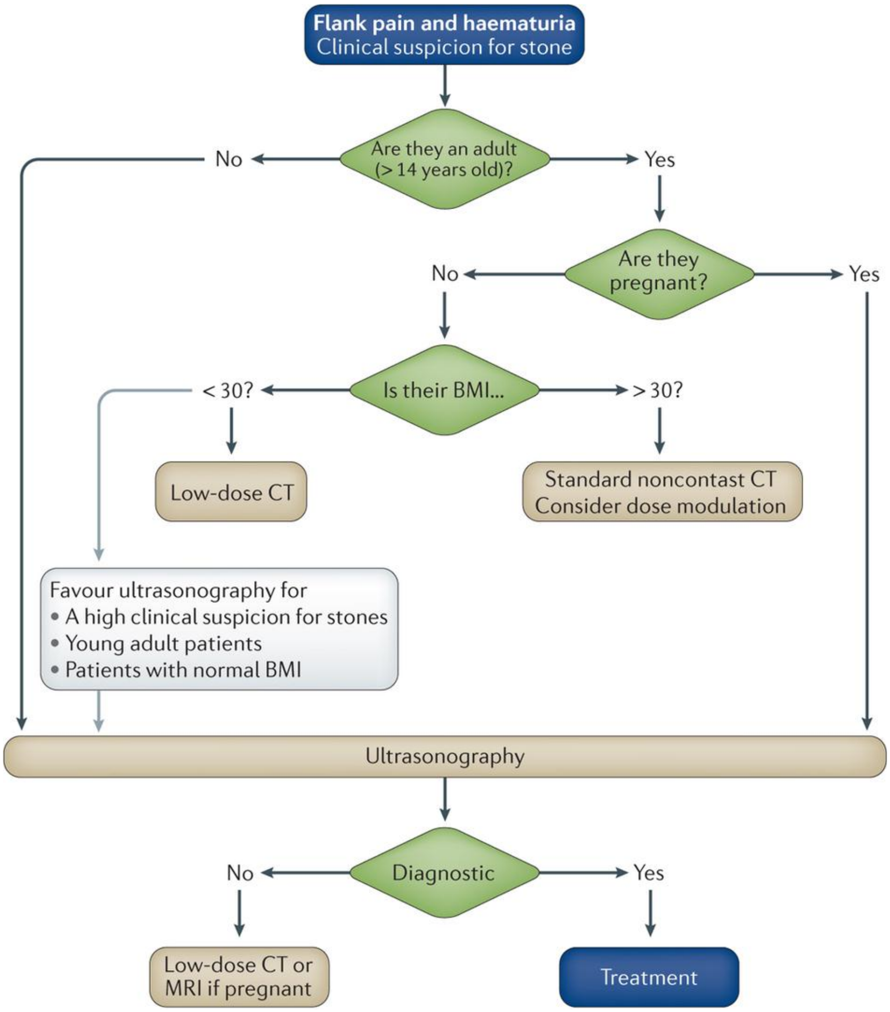

Fig. (1): A proposed algorithm for imaging patients with acute stone disease in the emergency department.

Initial stratification is based on age; American Urological Association (AUA) guidelines delineate patients <14 years old as paediatric patients. Adult patients are stratified based on whether they are pregnant and BMI.

Ultrasonography should also be considered first in adult patients, especially those with a normal BMI and adults in whom a reasonable suspicion of stone disease exists. In such cases the sensitivity and specificity will be sufficiently high to augment the patient's pretest probability of having a kidney stone without considerably increasing the risk of missing alternative diagnosis. Low-dose CT, noncontrast CT with <3 mSv of radiation exposure.

2- <u>Imaging & Radiology:</u>

1. Kidney, ureter, bladder radiography

Historically, plain abdominal radiography (KUB) was the imaging modality of choice for the evaluation of urolithiasis. This was because most stones contained calcium and therefore would be expected to be visible on KUB. KUB plain film radiography and fluoroscopy use a single energy source to produce photons, which pass through tissues in an anterior-to-posterior orientation encountering a contralateral receiver. This technique uses the same fundamental concepts as CT but in a single plane. Historically, KUB radiography has been used to conduct an intravenous pyelogram, which enabled evaluation of the presence of hydronephrosis and obstruction. This modality was largely replaced with the introduction of CT as an imaging technique [28, 29].

Currently, the sensitivity and specificity of standard KUB radiography is estimated to be 57% and 76%, respectively [27].

Advantages of KUB radiography include relatively low ionizing radiation exposure compared with CT (0.15 mSv) and low cost (~10% of ultrasonography) [30].

Tomography can improve the diagnostic accuracy of KUB for the evaluation of renal stones but it increases the amount of radiation the patient is exposed to [31].

The AUA suggests use of this combined imaging approach for the evaluation of ureteral stone disease during stone passage or after treatment [32, 33].

Advances in KUB radiography fuse the low-radiation dose of KUB radiography with the computational imaging capacity of CT. Digital tomosynthesis integrates KUB radiography scout films taken in an arc around the patient - somewhat akin to a CT scan - with computer integration of the image data from an opposed detector. This procedure enables visualization of stones from multiple angles rather than simply anterior to posterior, and has been used extensively in breast imaging as an alternative screening modality for mammography [34, 35, and 36].

For patients with kidney stones, imaging at multiple angles improves sensitivity and specificity with scant increases in radiation exposure [37, 38].

KUB before PNL can determine stone composition {radiolucency} and thereby need for access and intraoperative monitoring. KUB can change the decision on how a stone is managed. One study reported that when a KUB is obtained after NCCT, the surgical management was changed in 17 of 100 patients based on information from KUB; eleven patients had radiolucent ureteric stones, for which ESWL was consequently not possible and who required endoscopic management, three were due to position/visibility of the stone on KUB [39].

KUB is more sensitive than NCCT scout image; Stones were seen on 47% (51/108 patients) of the CT scout films and 63 % (68/108 patients) of the KUB X-rays; this difference was significant (P=0.02) [40]. Therefore, scout images from NCCT cannot be used as a surrogate for a KUB [41].

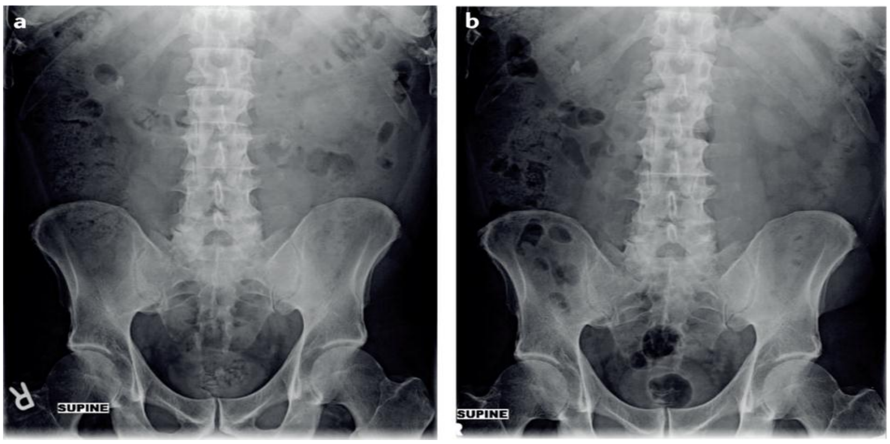

Fig. (2): Two plain films of the abdomen before and after treatment for an obstructing left-ureteral stone.

This patient also underwent CT imaging (Fig. 2). a | The left obstructing stone is clearly visible before treatment. b | After treatment the stone is no longer visible. Stones overlaying a bony structure, <5 mm or shaded by a bowel gas loop can easily be missed.

2. Intravenous Urography (IVU)

lVP was considered the standard imaging modality for evaluation of patients with renal stones. Currently, it is replaced by NCCT because of its superior sensitivity for detecting stones in these patients [22].

In the case of calyceal stones or milk of calcium stones, layering of the contrast can be helpful to evaluate the anatomy of the calyx harboring the stones [23].

3. Ultrasonography

Ultrasonography is commonly available, a low-cost(inexpensive) imaging modality that does not rely on ionizing radiation (poses no risk of radiation exposure)[41] and is becoming the primary alternative to CT outside the USA; however clinicians in the USA are now also moving towards this technique[42].

A wide range of sensitivities and specificities for ultrasonography have been reported, probably owing to variations in technique, body habitus, patient population and reference standards. Imaging stones in the renal pelvis and in the ureter also present different challenges as it is