EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY IN MANAGEMENT OF UROLITHIASIS IN CHILDREN

Thesis

Submitted in Partial Fulfillment of the
Degree of Master of Urology

By

Tamer Khodier Abd El-moaty
M.B.,B.Ch,

Under Supervision of

Prof. Dr. Mohammed Esmat Abu Ghareeb
Professor of urology
Faculty of medicine - Ain shams university

Dr. Ahmed Ibrahim Radwan
Lecturer of urology
Faculty of medicine - Ain shams university

Faculty of Medicine
Ain Shams University
2014

تفتيت الحصوات بالموجات التصادميه
فـدى الأطفـال

رسالـه

توطئه للحصول على درجة الماجستير

فى جراحة المسالك البوليه

مقدمه من

الطبيب/ تامر خضير عبد المعطى

ائكهنيه زلظس اوكجذح ذ

قكي بلظس ا – جئلع بىءلآ ز قمخني ذ

تحت إشراف

الاستاذ الدكتور / محمد عصمت أبو غريب

ىءزةئد جذح بلك لزلكقطكالهي ذ

قكي بلظس اأ جئلع ب عيم سدل ز

الدكتور / أحمد إبراهيم رضوان

لخذ ز جذح بلك لزلكقطكالهي ذ

قكي بلظس اأ جئلع ب عيم سدل ز

كلية الطب
جامعة عين شمس
2014

INTRODUCTION

Since the introduction of extracorporeal shockwave lithotripsy (ESWL) as a line of treatment of urolithiasis in the human beings at 1980 by **Chaussy,** the strategy of treatment of urinary tract stones had completely changed as ESWL is non-invasive procedure and has similar rates of stone clearance like other invasive and minimally invasive procedures which had proven by multiple researches ***(Chaussy et al., 1988).***

Extracorporeal shockwave lithotripsy **(ESWL)** is defined as the use of energy source that generate shock waves which is a special form of sound wave that have a sharp peak positive pressure followed by a trailing negative wave that when travelling from water to stone result in its fragmentation. Since the shock wave is generated outside the body so it is called extracorporeal ***(Stoller et al., 2007).***

Up to the end of I960, the conventional surgery was the only line of treatment of pediatric stones but in the mid of 1970, less invasive techniques like percutaneous nephrolithotomy **(PCNL)** and ureteroenscopy **(UR)** had proven to be a good alternatives for treatment of pediatric urinary stones. At 1986, Newman had introduced ESWL as a line of treatment of pediatric urinary stones and since when several studies had been done to assess the efficacy, safety and possible complications of ESWL on pediatric stones ***(Jalbani et al., 2010).***

The incidence of urinary tract stones in children is very low ranging from 0.1 %to 5 % of pediatric diseases and only accounts of 2-3 % of the total populations of patients presenting by urolithasis with slight prevalence in male children ***(Melanie et al., 2008).***

Anesthesia is required in about 30 % to 100 % of children who undergo lithotripsy. However this demand together with the anesthesia method itself differs considerably according to the age of the child. Older children may tolerate **ESWL** with intravenous analgesia or sedation using pharmacological agents such as Midazolam, ketamine or fentanyl. The need and the type of anesthesia are also depending on the type of the lithotriptor as electro-magnetic lithotriptor cause less pain and less symptoms than electro-hydraulic lithotriptors ***(Akosy et al., 2009).***

The goal of stones treatment is to achieve maximal stone clearance with minimal morbidity to the patient. ESWL as a non-invasive technique has considered to be the perfect choice of treatment in children as recurrence rate of stone former children is high ***(Musa et al., 2008).***

ESWL has been used extensively in children for fragmentation of both renal and ureteric stones. The higher success rate in children is due to nature of children ureter which is shorter, more elastic and distensible than the adult ureter so it can permit easier transmission of stones fragments and prevent stone impaction. Also the smaller body volume provide greater shockwave transmission and children tend to have more fragile stones ***(Shouman A.M. et al., 2009).***

There are a lot of factors affect the success rates of ESWL like stone size. Most studies advice it only for stone burden less than 2 cm. stones larger than 2.5 cm or multiple stones adversely affect stone clearance rates ***(Wadhwa P. et al., 2007).***

Among the predictors of success of stone free rates is the site of stones which seem to be controversial, several authors showed that ESWL of lower ureteric stones is less effective than stones of upper urinary tract due to special difficulties in visualizing stones overlying sacrum but other authors suggest that the efficiency of ESWL in ureteral stones can be improved by increasing numbers of shockwave delivered ***(Hammad F. et al., 2009).***

The need of ureteral stent is rare in children and is preserved only for difficult cases like increased stone burden, multiple stones, narrow infundibulo-pelvic angle or narrow infundibulum. These factors adversely affect the stone clearance rates so it is advised to fix a stent before ESWL in these cases ***(Tan Mo et al., 2006).***

In a special study that was comparing between stented and non-stented patients, it was found that stented group develop less attacks of renal colic, fever or emergency room (ER) visits but the overall clearance rates or steinstrasse is almost equal in both groups ***(Mohayuddin N. et al., 2009)***.

Although ESWL, as non-invasive technique, has no side effects or complications, yet very rare complications of the procedure had been reported like traumatic effects of shockwave energy to tissues as transient hematuria, lion pain, skin bruising or hemoptysis if it affect the lung. Also some complications due to obstructing effect of stones or steinstrasse like fever or urosepsis ***(Landau E.H. et al., 2009)***.

So, for the above mentioned, ESWL is considered as a good valuable methods for treatment of stone disease in children.

AIM OF THE WORK

This work aims to assess the efficacy and safety of extra corporeal shockwave lithotripsy (ESWL) in management of pediatric urinary stones.

RENAL ANATOMY

The kidneys are paired, reddish brown, solid organs that lie well protected deep within the retroperitoneal cavity. Each kidney is about 11.25 cm. in length, 5 to 7.5 cm. in breadth and rather more than 2.5 cm. in thickness. The left is somewhat longer, and narrower, than the right. The weight of the kidney in the adult male varies from 125 to 170 gm., in the adult female from 115 to 155 gm. The combined weight of the two kidneys in proportion to that of the body weight is about 1 to 240 ***(Wickham and Miller, 2001).***

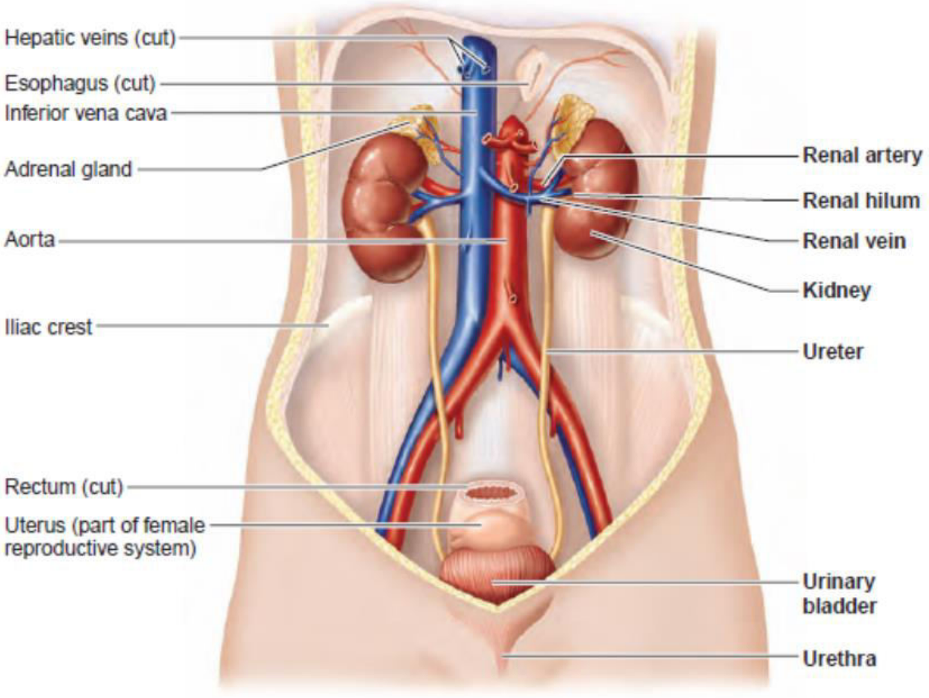

Figure (1): Show kidneys, suprarenal glands and great vessels.

Location and External Anatomy

The bean-shaped kidneys lie in a retroperitoneal position (between the dorsal body wall and the parietal peritoneum) in the superior lumbar region. Extending approximately from T12 to L3, the kidneys receive some protection from the lower part of the rib cage. The right kidney is crowded by the liver and lies slightly lower than the left. Because the kidneys lye in the posterior abdominal wall against the psoas major muscle, their longitudinal axis parallels the oblique course of the psoas which is conical in shape, the kidneys also are dorsally inclined on the longitudinal axis. Therefore, the superior poles are more medial and more posterior than the inferior poles. Because the hilar region is rotated anteriorly on the psoas muscle, the lateral borders of both kidneys are positioned posteriorly. The kidneys are angled 30° to 50° behind the frontal (i.e., coronal) plane ***(Williams et al., 1995).***

Peri-renal Coverings

The kidney surface is enclosed in a continuous covering of fibrous tissue, the renal capsule (i.e., true renal capsule). Each kidney in its capsule is surrounded by a mass of adipose tissue called the peri-renal fat, which lies between the peritoneum and the posterior abdominal wall. The peri-renal fat is enclosed by the renal fascia (i.e., Gerota's fascia). The renal fascia is enclosed anteriorly and posteriorly by another layer of adipose tissue called the Para renal fat, which varies in thickness ***(Hinman et al., 1993).***

The renal fascia has two layers; the posterior layer is well-defined strong structure, whereas the anterior layer is more delicate and tends to adhere to the peritoneum. The anterior and posterior layers of the renal fascia (i.e., Gerota's fascia) subdivide the retroperitoneal space into three potential compartments: the posterior Para renal space, which contains fat only; the intermediate Para renal space, which contains the suprarenal glands, kidneys, and proximal ureters, together with the peri-renal fat and the anterior Para renal space ***(Harold et al., 2003).***

The anterior Para renal space extends across the midline from one side of the abdomen to the other; this space contains the ascending and descending colon, the duodenal loop, and the pancreas. Inferiorly, the layers of the renal fascia are fused around the ureter. Superiorly, the two layers of the renal fascia fuse above the suprarenal glands and its end fuse with the infra-diaphragmatic fascia. An additional fascial layer separates the suprarenal glands from the kidney. Laterally the two layers of the renal fascia fuse behind the ascending and descending colons. Medially, the posterior fascial layer is fused with the fascia of the spinal muscles. The anterior fascial layer merges into the connective tissue of the great vessels (i.e., aorta and inferior vena cava) ***(Harold et al., 2003).***

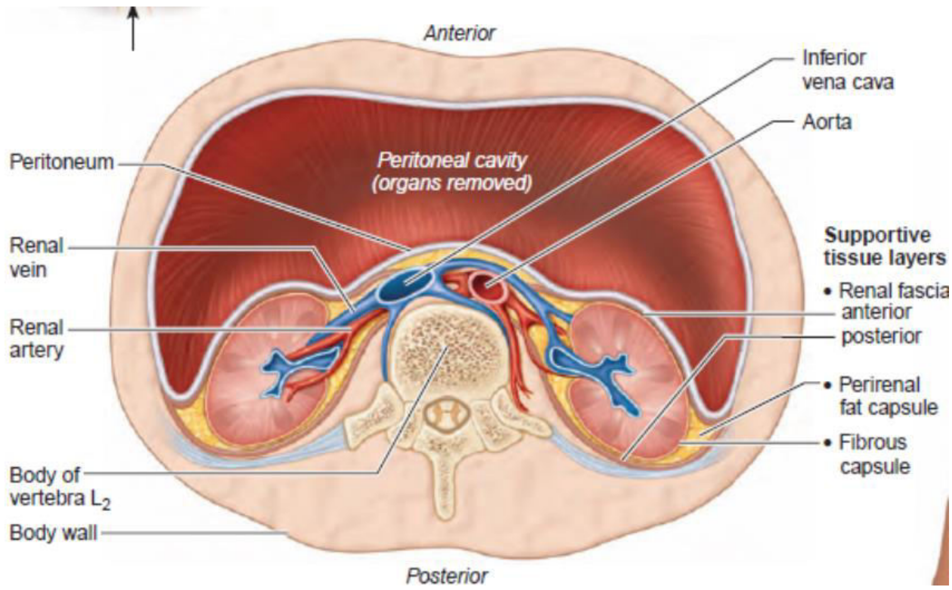

Figure (2): Cross section show position of the kidney and its coverings

The arrangement of the renal fascia potentially separates the right and left peri-renal spaces; therefore, complications of the endourologic procedures (e.g., hematoma, urinoma, peri-renal abscess) rarely involve the contralateral peri-renal space ***(Harold et al., 2003).***

Factors keeping the kidney in position

In addition to the Gerota's fascia, the vascular pedicle of the kidneys, the abdominal muscle tone, and the general bulk of the abdominal viscera support the kidneys. The kidneys are mobile organs and their positions varies with inspiratory or expiratory movement of the diaphragm as well as changes in position ***(Hinman et al., 1993).***

Anatomic Relationships

The position of the kidney within the retroperitoneum varies greatly by side, degree of inspiration, body position, and presence of anatomic anomalies. The right kidney sits 1 to 2 cm lower than the left in most individuals owing to displacement by the liver. Generally, the right kidney resides in the space between the top of the first lumbar vertebra to the bottom of the third lumbar vertebra. The left kidney occupies a more superior space from the body of the 12th thoracic vertebral body to the 3rd lumbar vertebra ***(Gaballah et al., 1995).***

Both kidneys have similar muscular surroundings. Posteriorly, the diaphragm covers the upper third of each kidney, with the 12th rib crossing at the lower extent of the diaphragm. Also important to note for percutaneous renal procedures and flank incisions is that the pleura extends to the level of the 12th rib posteriorly. Medially the lower two thirds of the kidney lie against the psoas muscle, and laterally the quadratus lumborum muscle and aponeurosis of the transversus abdominis muscle are encountered ***(Jone et al., 2003).***

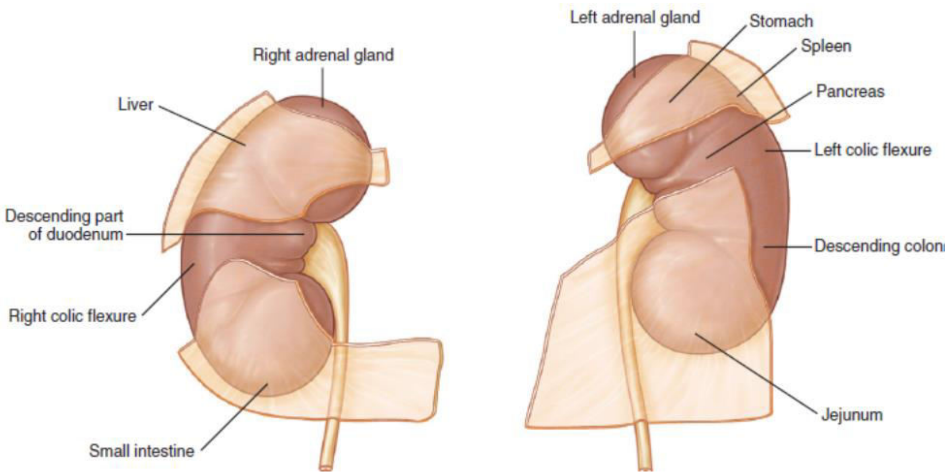

Figure (3): show anterior relationship of the kidneys

Anteriorly, the right kidney is bordered by a number of structures. Cranially, the upper pole lies against the liver and is separated from the liver by the peritoneum except for the liver's posterior bare spot. The hepatorenal ligament further attaches the right kidney to the liver because this extension of parietal peritoneum bridges the upper pole of the right kidney to the posterior liver. Also at the upper pole, the right adrenal gland is encountered. On the medial aspect, the descending duodenum is intimately related to the medial aspect of the kidney and hilar structures. Finally, on the anterior aspect of the lower pole lies the hepatic flexure of the colon ***(Kyle Anderson et al., 2007).***

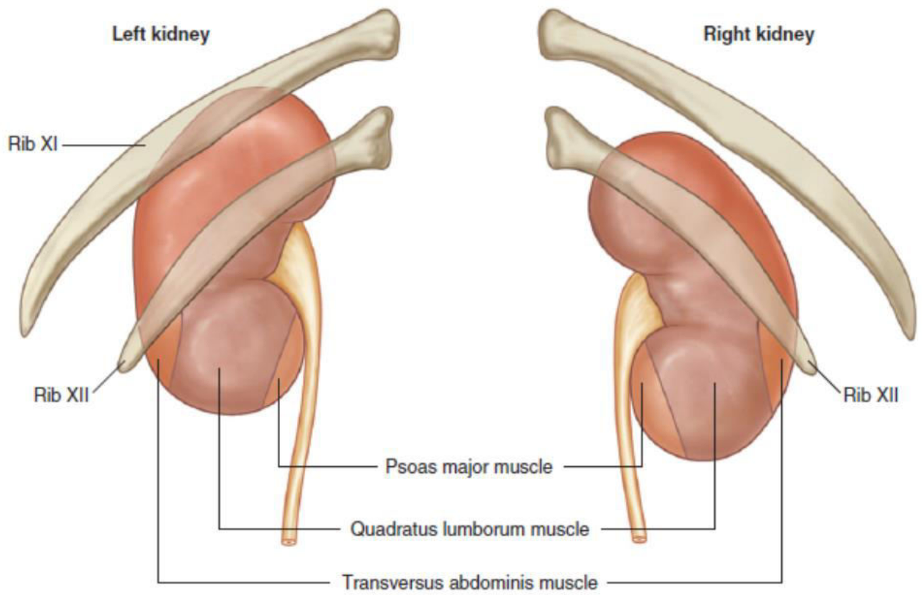

Figure (4): Show posterior relationship of the kidneys

The left kidney is bordered superiorly by the tail of the pancreas with the splenic vessels adjacent to the hilum and upper pole of the left kidney. Also cranial to the upper pole is the left adrenal gland and further superolaterally, the spleen. The splenorenal ligament attaches the left kidney to the spleen. This attachment can lead to splenic capsular tears if excessive downward pressure is applied to the left kidney. Superior to the pancreatic tail, the posterior gastric wall can overlie the kidney. Caudally, the kidney is covered by the splenic flexure of the colon ***(Sampaio et al., 1993).***

Intra-renal Anatomy, the Pelvi-calyceal Anatomy

A frontal section through a kidney reveals three distinct regions: cortex, medulla, and pelvis. The most superficial region, the renal cortex, is light in color and has a granular appearance. Deep to the cortex is the darker, reddish-brown renal medulla, which exhibits cone-shaped tissue masses, called medullary or renal pyramids. The broad base of each pyramid faces toward the cortex, and its apex, or papilla (nipple), points internally. The pyramids appear striped because they are formed almost entirely of parallel bundles of microscopic urine-collecting tubules and capillaries. The renal columns, inward extensions of cortical tissue, separate the pyramids. Each pyramid and its surrounding cortical tissue constitute one of approximately eight lobes of a kidney ***(Kaye et al., 1985).***

The renal pelvis, a funnel-shaped tube, is continuous with the ureter leaving the hilum. Branching extensions of the pelvis form two or three major calyces. Each one subdivides to form several minor calyces, cup-shaped areas that enclose the papillae. The division of the renal pelvis and the number and distribution of the calyces are the most variable components of the renal anatomy, and may be likened to an individual's fingerprint. The renal collecting system has its origins microscopically in the renal cortex at the glomerulus, where the first urinary filtrate enters Bowman's capsule, after which it flows through the rest of the nephron till it reaches the collecting tubules ***(Resnick et al., 1996).***

The collecting tubules coalesce as collecting ducts as they again extend inward through the renal medulla to empty on the apex of the medullary pyramid, the renal papilla. The renal papillae may number as few as 4 or as many as 18, but 7 to 9 are present in