INTRODUCTION

Mankind has been afflicted by urinary stone disease for thousands of years. The oldest renal stone was described by Shattock in 1950, in an Egyptian mummy in a tomb dating to 4400 BCE ***(Modlin, 1980)***. The treatment of renal stones has changed dramatically over the time. In 1981, Alken et al popularised percutaneous nephrolithotomy (PCNL), which has a high success rate, and since then PCNL has been widely accepted ***(Alken et al., 1981)***.

However, after the introduction of extracorporeal shockwave lithotripsy (ESWL), the use of the procedure declined. As clinical experience with ESWL increased and the limitations of the technique became obvious, PCNL reemerged as an elective treatment for patients with large, multiple or staghorn stones. Over time, the therapeutic indications of each procedure have become fixed and a ‘‘co-existence’’ has been achieved ***(Luis et al., 2013)*****.**

Percutaneous nephrolithotomy (PCNL) has undergone considerable evolution driven by the improvement in access techniques, instrumentation, lithotripsy, and endoscopic technology. Efforts have also been made to decrease the procedure’s morbidity, analgesic requirements, and hospitalisation time ***(Deane and Clayman, 2007)*****.**

PCNL was initially performed with the patient in the supine-oblique position, but the prone position later became the conventional one. The prone Position provides a larger area for the percutaneous renal access, a wider space for instrument manipulation, and a claimed lower risk of splanchnic injury ***(Ibarluzea et al., 2007).***

It is, however, associated with patient discomfort, increased radiological hazard to the urologist's hands, and the need for several nurses to be present for intraoperative changes of the decubitus in case of simultaneous retrograde instrumentation of the ureter (implying evident risks related to pressure points and possible ocular, spinal, or peripheral nerve injuries) ***(Ibarluzea et al., 2007).***

The prone position also implies important anaesthesiological disadvantages Including circulatory, haemodynamic, and ventilatory difficulties, particularly in obese patients ***(Ibarluzea et al., 2007).***

In addition, the change of position from supine to prone is really a time-consuming procedure to perform carefully and has a certain potential for complications, because of the risk of neck or limb injury or dislodgement of the endotracheal tube ***(De Sio et al., 2008).***

Most urologists are reluctant to change from the prone position to the supine one. Two conditions may explain this reluctance. First, the prone position is the safest position due to the believed low risk of colonic and vascular injuries. Secondly, it is difficult to shift from a surgical technique that has a low rate of complications ***(Luis et al., 2013).***

The first large clinical series of supine PCNL (sPCNL) was reported by Valdivia-Uria. His technique was further improved by Ibarluzea, opening the era of endoscopic combined intrarenal surgery. Its advantages are: easier anesthesia management, single positioning, and simultaneous anterograde and retrograde access to the urinary tract ***(Steele and Marshall, 2007).***

ECIRS (Endoscopic Combined IntraRenal Surgery) is a novel way of performing PNL in a modified supine position and a new comprehensive attitude of the urologist toward the various PNL steps. It combines a simultaneous antero-retrograde approach to the renal cavities and aims at the one-step and one-access resolution of urolithiasis along the whole urinary tract, exploiting at the best a full array of endourologic equipment ***(Scoffone et al., 2010)***.

ECIRS summarizes all the main issues debated in recent years about percutaneous renal surgery, namely patient positioning, synergy between operators, procedures, instrumentation, accessories and diagnostic tools, step-by-step standardization along with versatility in the intraoperative management of the surgical sequence, minimization of radiation exposure, broadening to particular and/or complex patients, limitation of post-operative renal damage ***(Cracco et al., 2011).***

AIM OF THE WORK

The aim of the study is to assess the feasibility, the efficacy and the morbidity of simultaneous antegrade and retrograde endourological management of urinary tract calculi.

Chapter 1

ANATOMY

***General feature*:**

The kidneys are paired organs lying retroperitoneal on the posterior abdominal wall. Each kidney has a characteristic shape, with a superior and an inferior pole, a convex border placed laterally, and a concave medial border. The medial border has a marked depression, the hilum, containing the renal vessels and renal pelvis ***(Drake et al., 2007).***

In adults, its approximate weight is 135 g in women and 150 g in men. The left kidney is larger than the right. The right kidney has a mean length of 10.97 cm and 3.21 cm mean thickness at the hilum, in comparison to 11.21 cm and 3.37 cm, respectively, for the left kidney ***(Marieb et al., 2012).***

Position of the Kidneys:

As the kidneys lie on the posterior abdominal wall, against the psoas major muscles; their longitudinal axis parallels the oblique course of the psoas **(Fig.1).** Moreover, since the psoas major muscle has a shape of a cone, the kidneys also are dorsal and inclined on the longitudinal axis. Therefore, the superior poles are more medial and more posterior than the inferior poles. As the hilar region is rotated anteriorly on the psoas muscle, the lateral borders of both kidneys are posteriorly positioned. It means that the kidneys are angled 30 to 50° behind the frontal (coronal) plane ***(Fig.1) (Drake et al., 2007).***

The position of the kidney within the retroperitoneum varies greatly by side, degree of inspiration and body position. 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 1st lumbar vertebra to the bottom of the 3rd lumbar vertebra. The left kidney occupies a more superior space from the body of the 12th thoracic vertebral body to the 3rd lumbar vertebra. The kidneys may move upward and downward approximately 1 to 7 cm with expiration and inspiration respectively ***(Sampaio, 2007).***

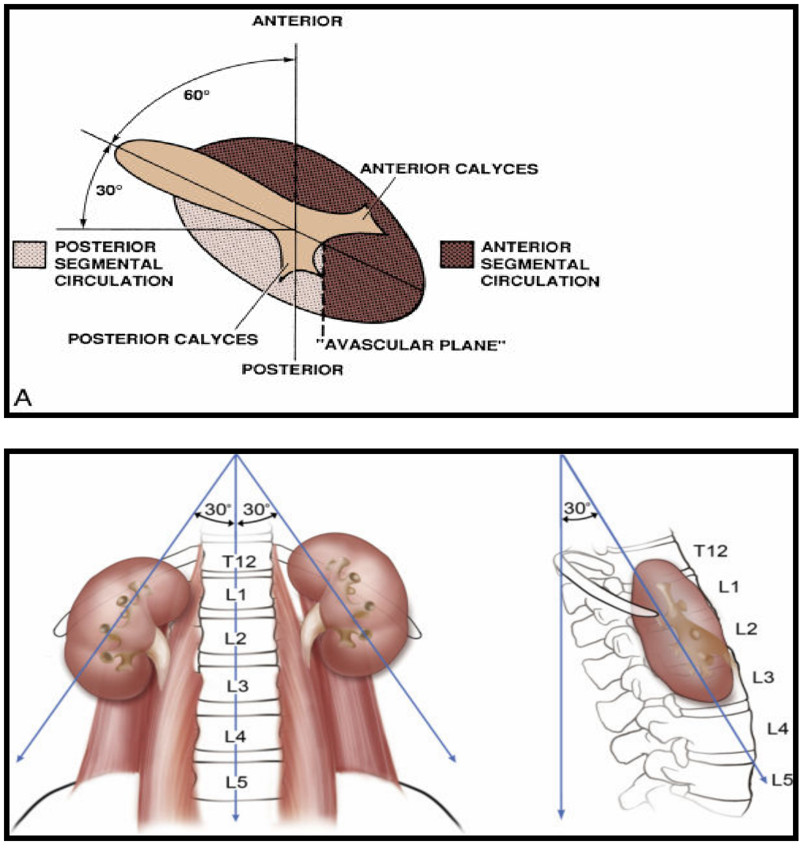

Figure (1): Normal rotational axes of the kidney. A, Transverse view showing approximate 30-degree anterior rotation of the left kidney from the coronal plane, relative positions of the anterior and posterior rows of calyces, and location of the relatively avascular plane separating the anterior and posterior renal circulation. B, Coronal section demonstrating slight inward tilt of the upper poles of the kidneys. C, Sagittal view showing anterior displacement of the lower pole of the right kidney Quoted from ***(wolf 2012).***

<u>Perirenal Coverings:</u>

The kidney surface is enclosed in a continuous covering of fibrous tissue, the renal capsule (“true renal capsule”). Each kidney within its capsule is surrounded by a mass of adipose tissue, lying between the peritoneum and the posterior abdominal wall (Figures 2 and 3). This perirenal fat is enclosed by the renal fascia (the so-called fibrous renal fascia of Gerota). The renal fascia is enclosed anteriorly and posteriorly by another layer of adipose tissue, the pararenal fat, which varies in thickness.

The renal fascia is made up of a posterior layer (a well defined and strong structure) and an anterior layer (a more delicate structure, which tends to adhere to the peritoneum) (Figures 2 and 3). The anterior and posterior layers of the renal fascia (fascia of Gerota) subdivide the retroperitoneal space into three potential compartments ***(Marieb et al., 2012).***

These compartments are: (1) the posterior pararenal space, which contains only fat; (2) the intermediate perirenal space, which contains the suprarenal glands, kidneys, and proximal ureters, together with the perirenal fat; and (3) the anterior pararenal space, which unlike the posterior and intermediate spaces, extends across the midline from one side of the abdomen to the other. This latter space contains the ascending and descending colon, the duodenal loop, and the pancreas.

Inferiorly, the layers of the renal fascia end weakly fused around the ureter .Superiorly, the two layers of the renal fascia fuse above the suprarenal gland and end fused with the infradiaphragmatic fascia. An additional fascial layer separates the suprarenal gland from the kidney (Figure 2 and 3).

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 spine muscles. The anterior fascial layer merges into the connective tissue of the great vessels (aorta and inferior vena cava). ***(Sampaio, 2007).***

These anatomic descriptions of the renal fascia show that the right and left perirenal spaces are potentially separated and, therefore, it is exceptional that a complication of an endourologic procedure, e.g. hematoma, urinoma, or perirenal abscess, involves the contralateral perirenal space.

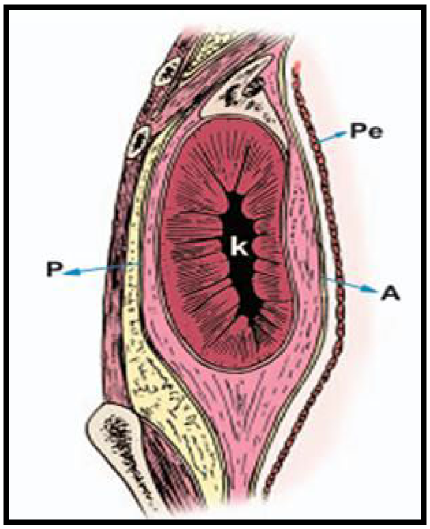

Figure (2): Lateral view of the retroperitoneum, the posterior *(P)* and the anterior *(A)* layers of the renal fascia. *Pe* = peritoneum; *K* = kidney ***(Sampaio, 2007).***

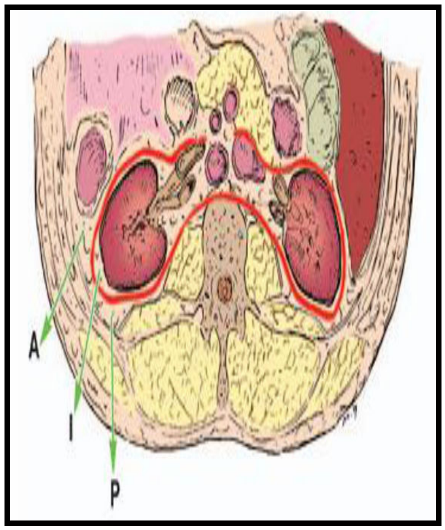

Figure (3): Superior view of a transverse section of the kidneys at the level of the 2nd lumbar vertebra shows the three compartments of the retroperitoneal space ***(Sampaio, 2007).***

Anatomical relationships of the kidneys:

- **Kidney Relationships with Diaphragm, Ribs, and Pleura**:

The kidneys lie on the psoas and quadratus lumborum muscles. The posterior surface of the right kidney crossed by the 12^{th} rib and the left kidney crossed by the 11^{th} and 12^{th} ribs .The posterior surface of the diaphragm attaches to the extremities of the 11^{th} and 12^{th} ribs. Close to the spine, the diaphragm is attached over the posterior abdominal muscles and forms the medial and lateral arcuate ligaments on each side **(Fig.4).** In this way, the posterior aspect of the diaphragm (posterior leaves) arches as a dome above the superior pole of the kidneys, on each side. ***(Marieb et al., 2012).***

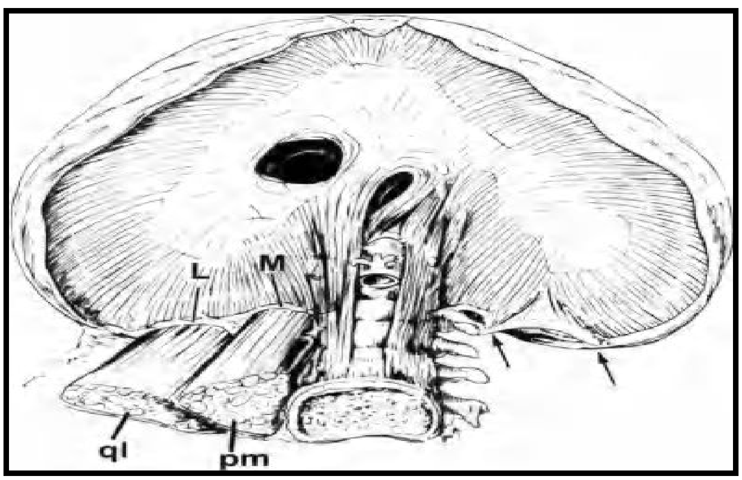

Figure (4): Schematic of an inferior view of the diaphragmatic dome. The arrows point to the diaphragmatic attachments to the extremities of the 11th and 12th ribs. **M,** medial arcuate ligament; **L**, lateral arcuate ligament; **ql**, quadratus lumborum muscle; **pm**, psoas muscle. ***(Sampaio, 2007).***

The posterior reflection of the pleura extends inferiorly to the 12th rib; nevertheless, the lowermost lung edge lies above the 11th rib (at the 10th intercostal space) **(Fig.5).** Regardless of the degree of respiration (mid- or full expiration), the risk of injury to the lung from a 10th intercostal percutaneous approach to the kidney is prohibitive. Any intercostal puncture should be made in the lower half of the intercostal space, in order to avoid injury to the intercostals vessels above ***(Sampaio, 2007).***

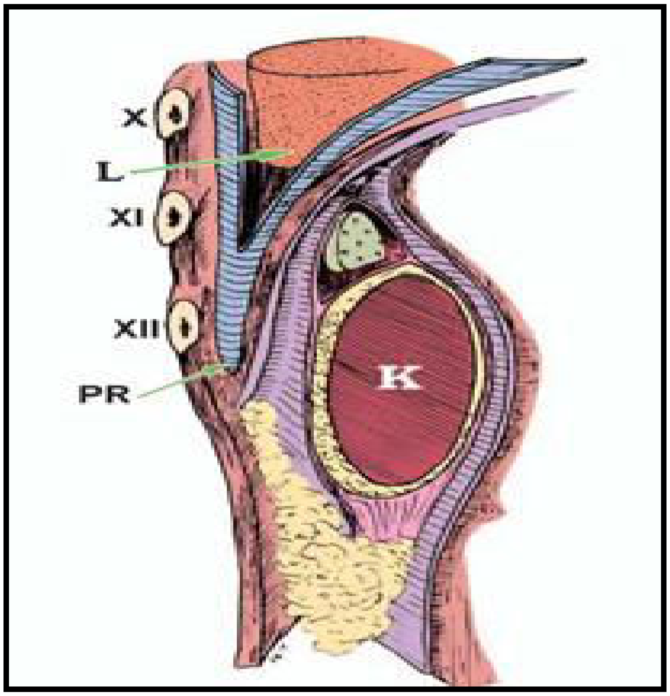

Figure (5): Schematic drawing from a lateral view of the kidney and its relationships with the diaphragm, ribs, pleura, and lung ***(Sampaio, 2007).***

- **Kidney Relationships with Liver and Spleen:**

The liver on the right side and the spleen in the left may be posterolaterally positioned at the level of the suprahilar region of the kidney, because at this point, these organs have their larger dimensions ***Figure (6).*** Therefore, one may remember that a kidney puncture performed high in the abdomen has little space for the needle entrance). If the intrarenal puncture is performed when the patient is in mid- or full inspiration, the risk to the liver and spleen is increased. This knowledge is particularly important in patients with hepatomegaly or splenomegaly, on whom a computed tomography (CT) scan should be performed before puncturing the kidney ***(Drake et al., 2007).***

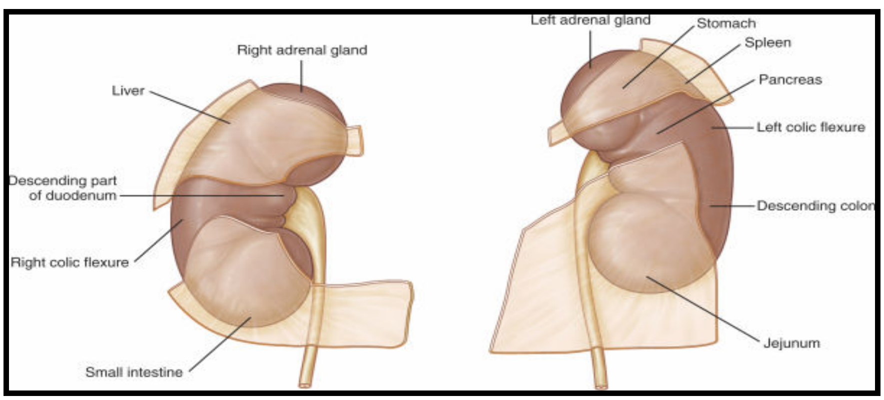

Figure (6): Structures related to the anterior surfaces of each kidney ***(Drake et al., 2007).***

- **Kidney Relationships with Ascending and Descending Colons:**

The ascending colon runs from the ileocaecal valve to the right colic flexure (hepatic flexure), where it passes into the transverse colon. The hepatic colic flexure (hepatic angle), lies anteriorly to the inferior portion of the right kidney. The descending colon extends inferiorly from the left colic flexure (splenic flexure) to the level of the iliac crest. The left colic flexure lays anterolateral to the left kidney. ***Figure (6) (Drake et al., 2007).***

Pelvicalyceal system:

- **Basic Interarenal Anatomy:**

On a longitudinal section, the renal parenchyma basically consists of two kinds of tissue, the cortical tissue and medullar tissue. The cortex forms the external layer of renal parenchyma. The renal medulla is formed by several inverted cones (renal pyramid), surrounded by a layer of cortical tissue on all sides (except at the apices). The apex of this pyramid is termed the renal papilla. The layers of cortical tissue between adjacent pyramids are termed renal columns (cortical columns of Bertin) ***(Kaye, 1984). Figure (7)***

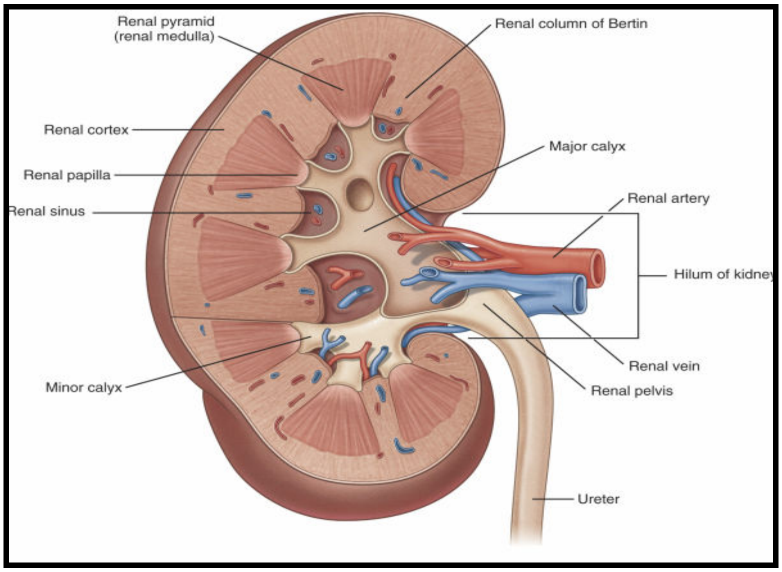

Figure (7): Internal structure of the kidney ***(Drake et al., 2007).***

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 (about 20), which open at the papillary surface (area cribosa; and drain urine into the collecting system (into the fornix of a minor calyx) ***(Drake et al., 2007).***

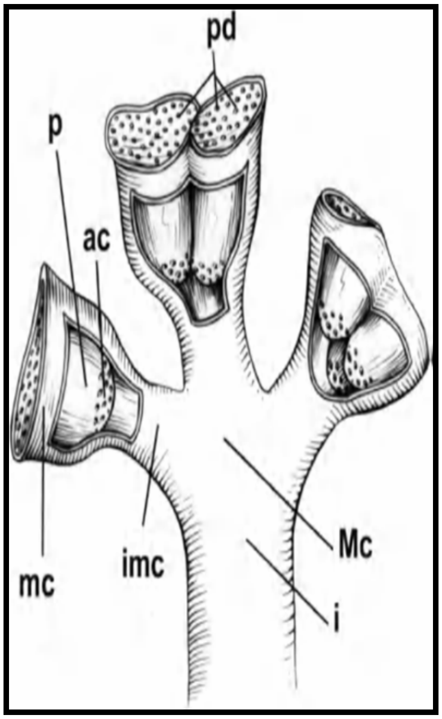

Figure (8): Schematic representation of the possible minor calyx (mc) arrangements. p, renal papilla; pd, papillary ducts; ac, area cribosa; Mc, major calyx; imc, infundibulum of a mc (calyceal neck); i, Infundibulum ***(Sampaio, 2007)***

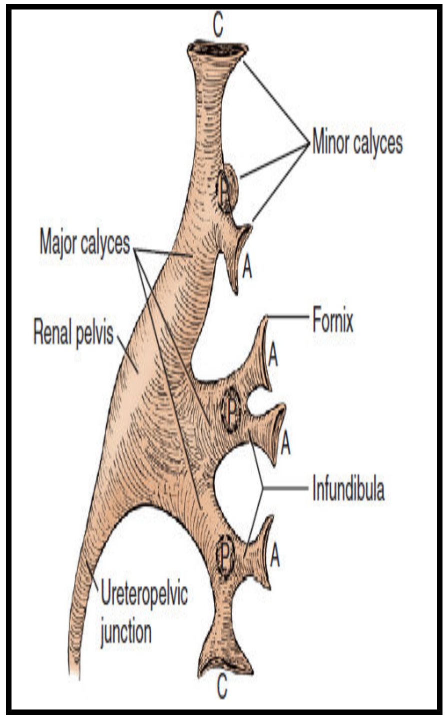

Figure (9): The renal collecting system (left kidney) showing major divisions into minor calyces, major calyces, and renal pelvis. A, anterior minor calyces; C, compound calyces at the renal poles; P, posterior minor calyces***(Sampaio, 2007)***

A minor calyx is defined as the calyx that is in immediate opposition to a papilla. The renal minor calices drain the renal papillae and range in number from 5 to14 (mean, 8). A minor calyx may be single (drains one papilla) or compound (drains two or three papillae). The minor calices may drain straight into an infundibulum or join to form major calices,