SUPINE PERCUTANEOUS NEPHROLITHOTOMY: SAFETY AND EFFECTIVNESS

Thesis

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Master Degree in ***Urology***

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INTRODUCTION

The incidence of nephrolithiasis worldwide is approximately 1%. A recent study suggests that the prevalence of stone disease continues to rise, particularly in women, thought to be due to changes in diet and lifestyle. The recurrence rates for stone disease are high. After an initial stone, there is a 30% to 50% chance of forming a second stone within 5 years ***(Scales et al., 2007)***.

The Risk of renal stones is associated with multiple factors including sex, geographic region, diet, fluid intake, and socioeconomic status for example; urolithiasis is more prevalent in whites and is relatively rare in African Americans and Native Americans ***(Srivastava and Alon, 2005).***

The Peak incidence of stone formation has been reported in the late summer and fall months, thought likely related to relative dehydration secondary to warm weather ***(Sternberg et al., 2005).***

Treatment of renal stones falls into 2 categories: observational and interventional. Medical management includes symptomatic treatment and aggressive hydration. Immediately, intravenous hydration at 1.5 to 2 times the maintenance rate is recommended. Pain associated with renal colic is best treated with narcotic analgesics combined with nonsteroidal anti-inflammatory medications ***(Safdar et al., 2006).***

The Common interventions include extracorporeal shockwave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), open surgery, and laprascopic. Extracorporeal shockwave lithotripsy is used with stones in various locations but is limited with larger lower pole stones, staghorn stones, and with the anatomically abnormal urinary tract ***(Dogan and Tekgul, 2007).***

Percutaneous nephrolithotomy is useful for large, lower pole stones, and staghorn stones ***(Beth and Bernadette, 2011).***

Percutaneous nephrolithotomy (PCNL) in the prone position has been considered the gold standard for the treatment of kidney stones >2 cm. However, during the last few years, a new approach in modified lithotomy position has been proposed with the purpose of simplifying the procedure and improving its efficacy ***(Andras et al., 2011).***

The first large clinical series of supine PCNL was reported by Valdivia-Uria ***(Valdivia et al., 1998).*** His technique was further improved by Ibarluzea ***(Ibarluzea et al., 2007).***

Opening the era of endoscopic combined intrarenal surgery.This approach is becoming increasingly popular worldwide, and its advantages are widely documented: easier anesthesia management, single positioning, and simultaneous anterograde and retrograde access to the urinary tract ***(Steele and Marshall, 2007).***

Fibrin sealant is used for three major reasons in urologic surgery as a hemostatic agent, a urinary tract sealant, or a tissue adhesive. Fibrin sealant's unique properties as a hemostatic agent, promotes an effective role in managing complex urologic injury and promoting wound healing in the genitourinary tract, and it has a hemostatic role in percutaneous nephrolithotomy ***(Shekarriz and Stoller, 2002).***

There are several advantages to the supine position for the patient and the urologist, with great versatility of stone manipulation along the whole upper urinary tract. The technique is safe, and it provides stone clearance rates comparable to those of conventional PCNL in the prone position ***(Ng et al., 2004).***

AIM OF THE WORK

This study will be conducted as a complete Evaluation of supine percutaneous nephrolithotomy as regard the procedure, advantages, disadvantages and postoperative safety.

ENDOUROLOGIC ANATOMY OF THE KIDNEY

General Anatomy:

The kidneys are paired organs lying retroperitoneal on the posterior abdominal wall. Each kidney is of a characteristic shape, having 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 the renal pelvis ***(Drake et al., 2007).***

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. 2)** ***(Drake et al., 2007).***

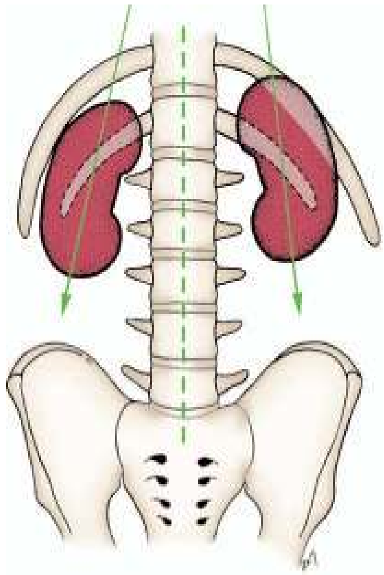

Figure (1): Anterior view of the kidneys in relation to the skeleton, shows that the longitudinal axis of the kidneys are oblique ***(Sampaio, 2000).***

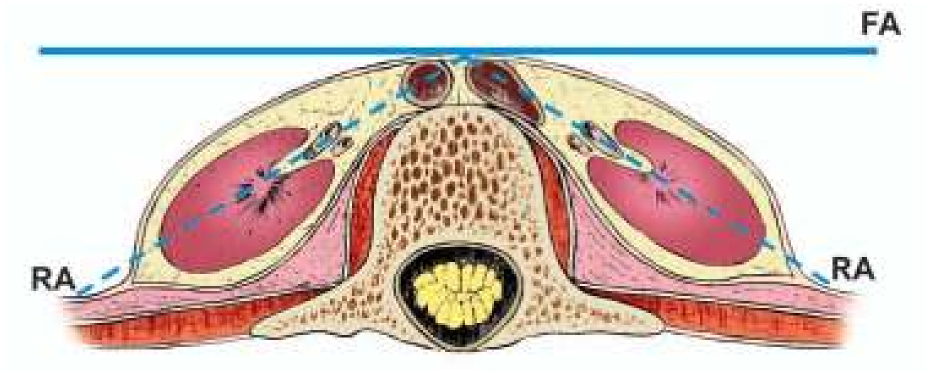

Figure (2): Superior view of a transverse section of the kidneys at the level of the 2nd lumbar vertebra ***(Sampaio, 2000).***

Perirenal Coverings:

The kidney surface is enclosed in a continuous covering of fibrous tissue called the "renal capsule" or "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 called the perirenal fat **(Fig.2&4).** The perirenal fat is enclosed by the renal fascia (so-called fibrous renal fascia of Gerota's fascia). The renal fascia is enclosed anteriorly and posteriorly by another layer of adipose tissue, which varies in thickness, called the pararenal fat ***(Fig. 4) (Sampaio, 2000).***

The renal fascia comprises a posterior layer (a well-defined and strong structure) and an anterior layer, which is a more delicate structure that tends to adhere to the peritoneum **(Fig. 2 & 4).** The anterior and posterior layers of the renal fascia (Gerota's fascia) subdivide the retroperitoneal space in three potential compartments **(Fig. 3).**

(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.

(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 space contains the ascending and descending colon, the duodenal loop and the pancreas ***(Sampaio, 2000).***

Inferiorly, the layers of the renal fascia end weakly fusing around the ureter. Superiorly, the two layers of the renal fascia fuse above the suprarenal gland and end fused with the infra-diaphragmatic fascia. An additional fascial layer separates the suprarenal gland 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 spine muscles. The anterior fascial layer merges into the connective tissue of the great vessels (Aorta and IVC) **(Fig.2&4).** These anatomic descriptions of the renal fascia show that right and left perirenal spaces are potentially separated, and therefore, it is exceptional that a complication of an endourologic procedure (e.g., haematoma, urinoma, perirenal abscess) involves the contralateral perirenal space **(Fig.4)** ***(Drake et al., 2007).***

The true capsule and Gerota's fascia are of importance when performing a percutaneous renal surgery **(Fig.5).** As the needle is passed through the skin into the kidney, two areas of resistance are felt, the first is at the lumbodorsal fascia, and the second is at the true capsule. The renal capsule is a firm fibrous membrane that adheres to the underlying parenchyma. Passing the needle through this capsule is much like pushing a needle through cardboard in that there is some initial resistance to the needle's passage followed by sudden "give". At this point, the needle lies within the renal parenchyma and therefore moves upwards and downwards as the kidney moves with respiration ***(Sampaio, 2000).***

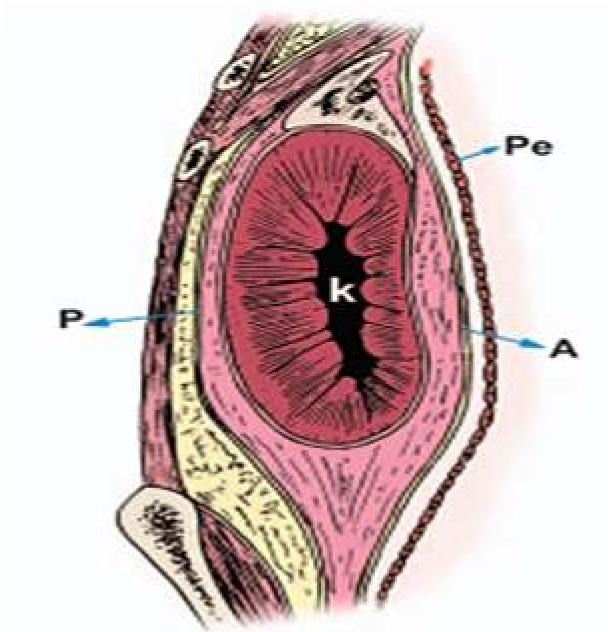

Figure (3): Lateral view of a longitudinal section through the retroperitoneum, reveals the posterior *(P)* and the anterior *(A)* layers of the renal fascia. *Pe* = peritoneum; *K* = kidney ***(Sampaio, 2000).***

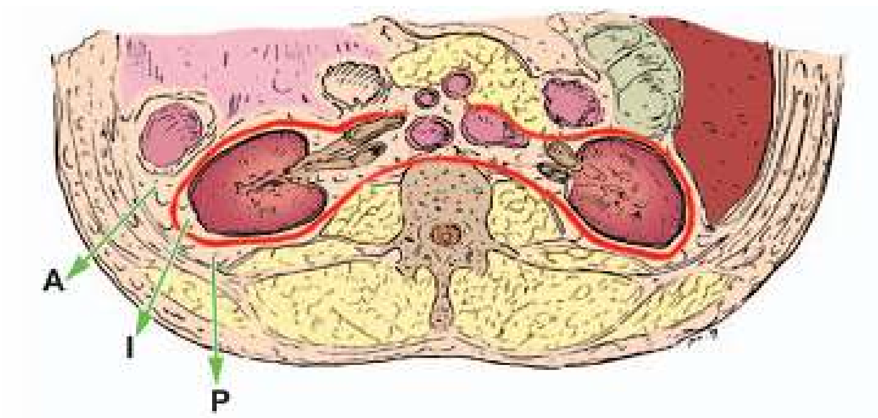

Figure (4): Superior view of a transverse section of the kidneys at the level of the 2nd lumbar vertebra shows the three compartments of the retroperitoneal space ***(Sampaio, 2000).***

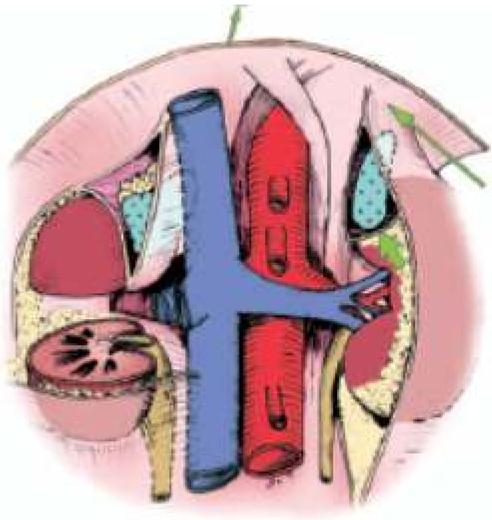

Figure (5): Anterior view of a schematic drawing of the renal fascia (Gerota's fascia) and the kidneys ***(Sampaio, 2000).***

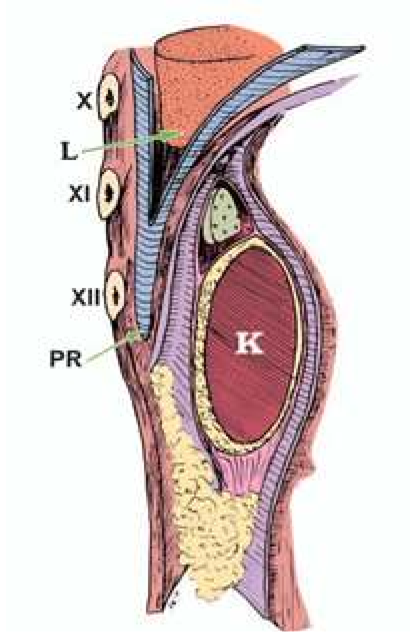

Figure (6): Schematic drawing from a lateral view of the kidney and its relationships with the diaphragm, ribs, pleura, and lung ***(Sampaio, 2000).***

Kidney Relationships with Diaphragm, Ribs, and Pleura:

The kidneys lie on the psoas and quadratus lumborum muscles. Usually, the left kidney is higher than the right kidney, being the posterior surface of the right kidney crossed by the 12th rib and the left kidney crossed by the 11th and 12th ribs **(Fig.1).** The posterior surface of the diaphragm attaches to the extremities of the 11th and 12th 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.6).** 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. Therefore, when performing a percutaneous renal access, endourologist may consider that the diaphragm is traversed by all intercostal punctures, and possibly by some punctures below the 12th rib ***(Hopper and Yakes, 1990)*** **(Fig.6).**

Generally, 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.7).** 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 inter-costal puncture should be made in the lower half of the intercostal space, in order to avoid injury to the intercostals vessels above ***(Hopper and Yakes, 1990).***

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**.** 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).***

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 ***(Hopper et al., 1987).***

Occasionally, it was observed in the course of routine abdominal CT scan examinations, that the retroperitoneal colon is lying in a posterolateral or even a post renal position. Hence, in these cases, it is at great risk of being injured during the intrarenal percutaneous approach. This event (retro renal colon) more commonly occurs with regard to the inferior poles of the kidneys. In a controlled study, it was demonstrated by CT scan that, when the patient is in the supine position, the retro renal colon was found in 1.9% of the cases. Nevertheless, when the patient assumes the prone position (the more frequent position used for percutaneous access to the kidney) the retro renal colon was found in 10% of the cases ***(Hopper et al., 1987).***

Retrorenal colon

Potential risk factors for colonic perforation include thin, habitus, extremely lateral PCN tract (lateral to the posterior-auxiliary line), dilated pelvic-calyceal system, colonic obstruction, megacolon, kyphoscoliosis and a hyper-mobile kidney ***(Noor, 2004).***

In the large series of 15 colonic perforations, significant independent risk factors were advanced patient age (associated with reduced perinephric fat) and the presence of a horseshoe kidney 3–19% retro-renal colon ***(El-Nahas et al., 2006).***

More frequently retro-renal colon is noted on the left side and it is more likely to be situated near the inferior pole of the kidney ***(Hopper et al., 1987).***

In a study of 500 CT scans reported that the frequency of retrorenal colon was 1.9% in the supine position. When 90 patients were studied in the prone position, a retro-renal colon was found in 10%. Moreover, the descending colon was more posterior to the lower pole of the left kidney. These findings may explain the greater incidence of colonic perforation during left-sided, lower calyceal approaches. ***(Prassopoulos et al., 1990).***

In an interesting study 708 consecutive abdominal CT scans and found that 0.9–14.2% of patients had parts of the colon posterior or posterior-laterally to the kidney. This anatomical abnormality cannot be picked up by intravenous urography or pre-operative ultrasound (US) both of which are commonly employed to evaluate patients prior to PCNL. Although pre-operative US could give some indication, the patient is usually in supine position and detection of this rare condition would require a high degree of suspicion ***(Noor, 2004).***

The CT scan is the imaging test of choice for the diagnosis of retro-renal colon. Chalasani et al studied the position of the colon relative to the kidney in 134 patients who underwent CT in the prone position. They found that the prevalence of retrorenal colon in males was 13.6% on the right, and 11.9% on the left, while in females it was 13.4% on the right and 26.2% on the left ***(Chalasani et al., 2010).***

As Tuttle et al. demonstrated the risk of colon injury is overestimated by evaluation of axial CT images alone compared with oblique parasagittal reformations ***(Tuttle et al., 2005).***