INTRODUCTION

After more than 30 years, percutaneous stone removal is the treatment of choice for large and/or complex urolithiasis. Instead of becoming obsolete over the decades, percutaneous nephrolithotomy (PCNL) underwent considerable evolution since its introduction in 1976, progressively acquiring a new configuration and accordingly improving its efficacy and safety in expert hands ***(Preminger, 2010)***.

The old static procedure become a technically updated to mini-invasive approach thanks to continuous advances regarding imaging techniques, anesthetic skills, patient positioning, renal access puncture, antegrade and retrograde use of semirigid and flexible endoscopes with better technology and vision, choice among a variety of accessories and intracorporeal lithotripsy devices, and postoperative renal drainage ***(Cracco et al., 2011)*.**

In 1955 the prone position was the one used by **Goodwin and collaborators** when they did the first percutaneous renal access and by **Fernström and Johansson** in 1976 when they described the percutaneous nephrolithotomy technique. It then became the traditional technique and the prone position provided a wide surgical field for renal puncture and adequate nephroscopic manipulation, easier upper pole puncture with a lower risk of lung, pleura, and liver/spleen injury, a good distension of the collecting system ***(Miano et al., 2010)***.

On the other hand, the anesthetic concerns of the prone position (especially in morbidly obese patients, those with compromised cardiopulmonary status or skeletal deformities) and the difficulty of obtaining a combined antegrade and retrograde access to the renal cavities, when needed are issues that have been overlooked for a long time ***(Cracco, 2010).***

A lot of modified positions have been proposed over the years, including the reverse lithotomy position of **Lehman and Scarpa**, the lateral decubitus of **Grasso and Kerbl** and the supine position of **Valdivia Urìa**, but none of them ever overthrown the usual prone position until recently. In the late 1980s **Valdivia Urìa** described already his experience with the supine approach for PCNL, publishing consistent clinical data on the efficacy and safety of this technique, but his results did not obtain the deserved consensus within the endourological community ***(Ibarluzea et al., 2007).***

The supine positions for PCNL are not the unique alternatives to the prone position, as demonstrated by the bulk of recent literature, proposing lateral, flank, split-leg modified lateral, flank prone, prone flexed, supine oblique, semisupine positions, and many others. The relevant aspect is that all these authors made their proposals in a common effort to improve their surgical percutaneous practice. Of course, feasibility, efficacy, and safety of PCNL performed in any alternative position have been compared to those of the prone PCNL, by now with substantially equivalent urological outcomes (in terms of stone-free rates, operative time, hospital stay, and complication rates) ***(Cracco et al., 2011).***

Among the advantages of PCNL performed in the supine position there are numbers of anesthesiological and urological advantages which have been widely reported. The cardiovascular, ventilatory, and pharmacokinetic problems of the prone position are overcomed in the supine positions, with better access to the airways and the cardiovascular system ***(Scoffone et al., 2008).***

Urological advantages include the possibility of an endovision-assisted renal puncture and tract dilation, a demonstrated decreased risk of colon injury, a great versatility in the combined stone manipulation, a better descending drainage and retrieval of stone fragments from lithotripsy because of the downward position of the Amplatz sheath, low intrarenal pressures implying less pyelovenous back flow and of postoperative infectious risk ***(Scoffone et al., 2013).***

The major disadvantage of the supine position is that the kidney is more easily pushed forward by the puncture needle and the fascial dilators, leading to the establishment of a deeper channel ***(Steel et al., 2007).***

AIM OF WORK

The aim of this work is to compare between supine and prone PCNL in the management of stag horn and multiple renal stones and stones more than 2 cm regarding stone free rate, operative time, drop of hemoglobin, complication postoperative.

SURGICAL ANATOMY OF THE KIDNEY AND RENAL AXIS

General Anatomy:

The kidney is a retroperitoneal organ on the posterior abdominal wall. Each kidney is of a characteristic shape, having a superior and inferior pole, a convex border and placed laterally, and concave medial border, the medial border has a marked depression, the hilum, containing the renal vessel and the renal pelvis ***(Sampaio, 2000)*.**

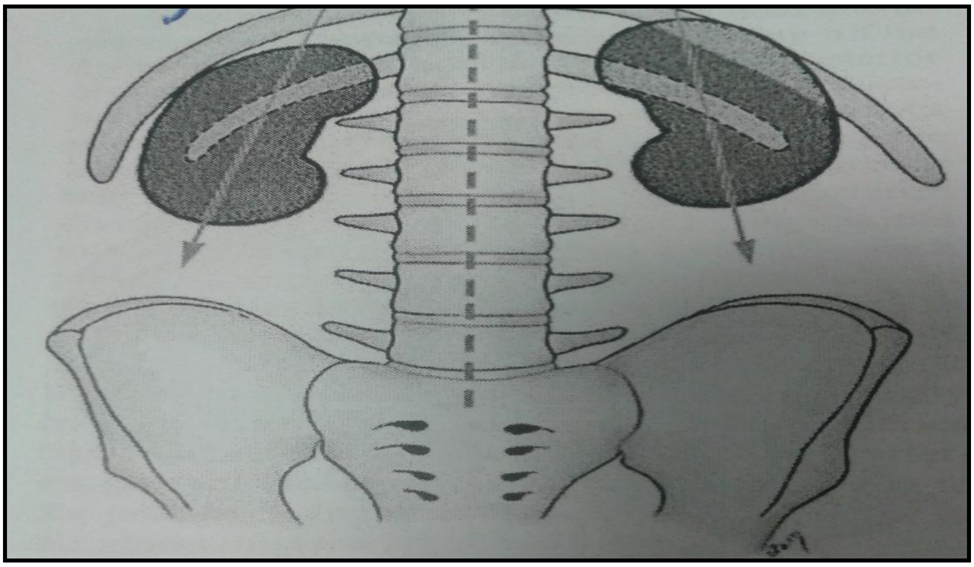

Figure (1): The kidneys related to the skeleton. A longitudinal axes of the kidney are oblique (arrows). The upper pole is closer to the midline than the lower pole. The right kidney upper pole starts at the 12th rib and the left kidney at the 11th and 12th ribs ***(Sampaio, 2000).***

Position of the kidneys:

The kidneys are lying on the posterior abdominal wall, especially the psoas major muscles, causing their longitudinal axis becoming parallel to the oblique course of the psoas***(Sampaio, 2000)*.**.

Moreover, since the psoas major muscle has a shape of a cone, the kidneys also are dorsal inclined on the longitudinal axis, therefore, the superior poles are more medial and more posterior than the inferior poles because the hilar edge is rotated anteriorly on the psoas muscle the lateral border of the both kidney are posteriorly positioned, it means that the kidney are angled 30 degrees to 50 degrees behind the frontal coronal plane ***(Sampaio, 2000)*.**

Relationships to the Kidneys

1) Kidney relationships with diaphragm, rib, and pleura:

The kidneys lie on the psoas and quadrate lumborum muscle, usually the left kidney is higher than the right kidney, being the posterior surface on the right kidney crossed by the 12^{th} rib and the left kidney crossed by the 11^{th} and 12^{th} ribs (see figure 1). While 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, 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 an intrarenal access by puncture, the urologist may consider that all intercostal punctures pass across the diaphragm, and possibly by some punctures below the 12^{th} rib. In most intercostal approaches the pleura passes through to the 12^{th} rib without symptom ***(Hopper et al., 1990)*.**

The posterior reflection of the pleura attached to the 12^{th} rib, and the lower edge of the lung lies above the 11^{th} rib at the 10^{th} intercostals space. During mid- or full expiration, if percutaneous approach to the kidney from 10^{th} intercostal space is required, it may lead to the risk of injury to the lung. Also needle puncture should be made in the lower half of the intercostals space, in order to avoid injury to the intercostals vessels above ***(Hopper et al., 1990)*.**

2) Kidney relationships with liver and spleen:

The liver on the right side and the spleen in the left at the level of the supra-hilar region on the kidney, because at this point, these organs have their larger dimensions making a kidney puncture performed high in the abdomen having little space for the needle entrance. If the 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, so computed tomography CT scan should be performed before puncturing the kidney on those kind of patients ***(Hopper et al., 1998).***

3) Kidney relationships with ascending and descending colons:

The ascending colon starts from the ileocolic valve up to the right colic flexure (hepatic flexure), and it passes into the transverse colon. This is important as the colic (hepatic) flexure lies anterior to the inferior portion of the right kidney. The descending colon extends inferiorly from the left colic flexure (splenic flexure) to of the iliac crest level. The left colic flexure lies anterolateral to the left kidney as seen in figure 2 ***(Hopper et al., 1998)*.**

By this anatomical background considering the position of the retroperitoneal ascending and descending colons is important. A routine abdominal CT scan examinations, may show a retroperitoneal colon is lying lateral or behind the kidney. 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 ***(Hopper et al., 1998)*.**

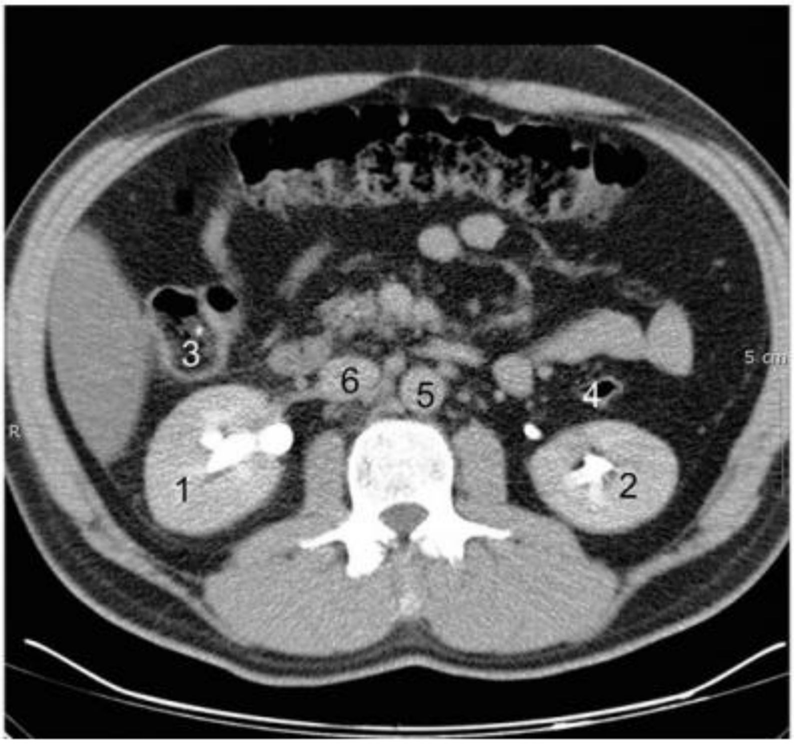

Figure (2): Abdominal CT scan at the level of kidneys in a patient in the supine position. 1: Right kidney; 2: Left kidney; 3: Ascending colon; 4 Descending colon; 5: Abdominal Aorta; 6: Inferior Vena Cava ***(Hopper et al., 1998)*.**

In the supine position the colon injury was found in 2% of the cases due to the retro renal position. When the patient assumes the prone position (the more frequent position used) the retro renal colon was found in 10% of the cases with increase in risk of injury. Special attention should be given under fluoroscopy with the patient in prone position ***(Hopper et al., 1998)*.**

Pelvicalyceal system: Endourologic implications

Basic Intrarenal Anatomy:

The renal parenchyma consist basically of two kinds of tissue, the cortical tissue and the medullar tissue. On a longitudinal section (figure 3) the cortex form the external layer of renal parenchyma. The renal medulla is formed by several inverted cones, surrounded by a layer of cortical tissue on all sides except at the apexes named renal columns (cortical columns of Bertini). The cone assumes the shape of a pyramid and the established expression for the medullar tissue is called the renal pyramid, the apex of a pyramid is the renal papilla (***Kaye et al., 1998)*.**

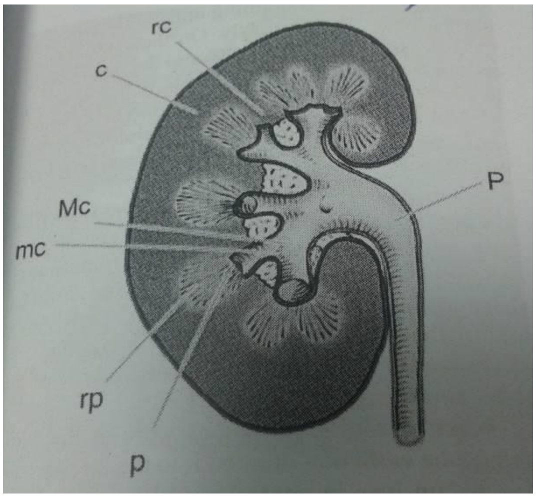

Figure (3): Renal cortex (C); renal column (cortical column of Bertini) (rc); renal pyramid (rp); renal papilla (p) = minor calyx (mc); = major calyx (Mc); renal pelvis (P) ***(Kaye et al., 1998)***

The cortical tissue consists of the glomeruli with proximal and distal convoluted tubules. The renal pyramids consist of the loops of Henle and collecting ducts. These ducts join to form the papillary ducts (about 20) which open at the papillary surface area (cribrosa papillae reanlis, figure 3) draining urine into the collecting system ***(Kaye et al., 1998)*.**

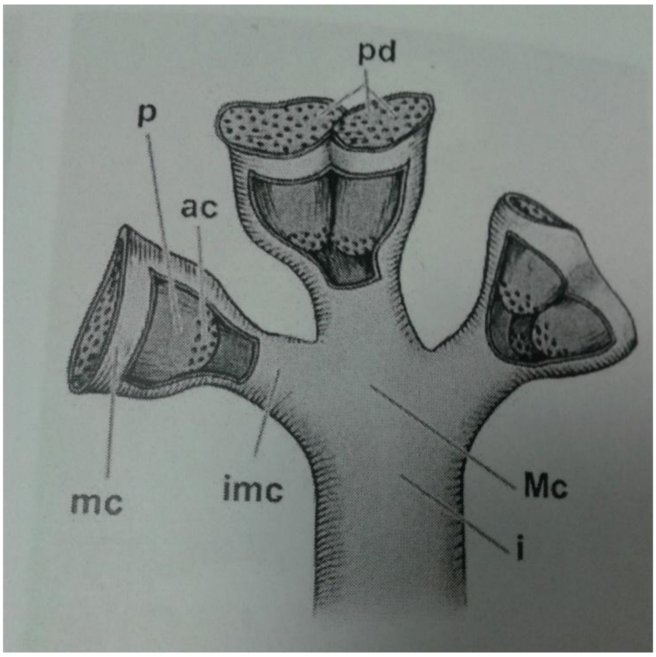

Figure (4): The minor calyx arrangement. A single minor calyx drains only one papilla and a compound minor calyx drains two or three papillae. P= renal papilla; Pd = papillary ducts; ac= area cribosa; mc = minor calyx; Mc= major calyx; imc = infundibulum of a minor calyx (caliceal neck); i= infundibulum ***(Kaye et al., 1998)*.**

A minor calyx is defined as the calyx that is in immediate apposition to a papilla, as seen in figure 4. The minor calyces draining the renal papillae range from 5 to 14 (mean 8), although the number of minor calyces is widely varied, we found 70% of the kidneys presenting 7 to 9 minor calyces. A minor calyx may drain one papilla or two or three papillae, the polar calyces often are compound markedly in superior pole ***(Sampio et al., 1998)*.**

The minor calyces may drains straight into an infundibulum or join to form major calyces, which subsequently will drain into an infundibulum, which are considered the primary divisions of the pelvicalyceal system, drain into the renal pelvis ***(Sampaio, 1998)*.**

Classification of the pelvicalyceal system:

Group A : composed of pelvicalycle system that present two major calyceal groups (superior and inferior) as a primary division of the renal pelvis and a mid-calyceal drainage dependent on these two major groups represent 62.2 % (figure 5). Group A are divided into two different types of pelvicalyceal systems ***(Sampaio, 1993)***

- **<u>Type A-I:</u>** 45% the kidney mid-zone is drained by minor calyces that are dependent on the superior or on the inferior calicle groups, or even on both superior and inferior calicle groups simultaneously ***(Sampaio, 1993)***
- **<u>Type A-II:</u>** 17.2 % the kidney mid-zone is drained by crossed calyces, one draining into the superior calyceal group and another draining into the inferior calyceal group ***(Sampaio, 1993)*.**

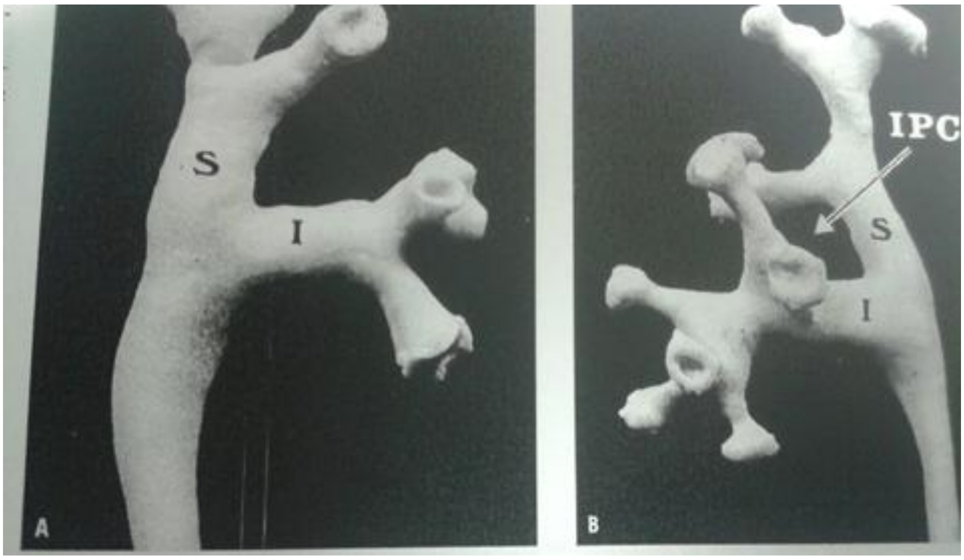

Figure (5): Type of the pelvicalyceal systems that constitute (**A)**. Type A-I anterior view of a left pelvicalyceal cast shows the kidney midzone drained by calyces dependent on the superior(S) and inferior (I) calyx. **(B)**, Type A-II anterior view of a right pelvicalyceal cast shows the kidney midzone drained by crossed calyces, dependent on the superior(S) and inferior (I) calyceal group simultaneously. The cast show the inter pelvicalyceal space (IPC) **(*Sampaio, 1993)***

Group B the group is composed of pelvi-calycle system that present the kidney hilar calycle drained independent of both the superior and the inferior calyx see figure 6. This group represent 37.8 % and also include two different types of pelvi-calicle systems ***(Sampaio 1991)*.**

- **Type B-I:** 21.4 % the kidney mid-zone is drained by a major calyceal group, independent of both the superior and the inferior groups.

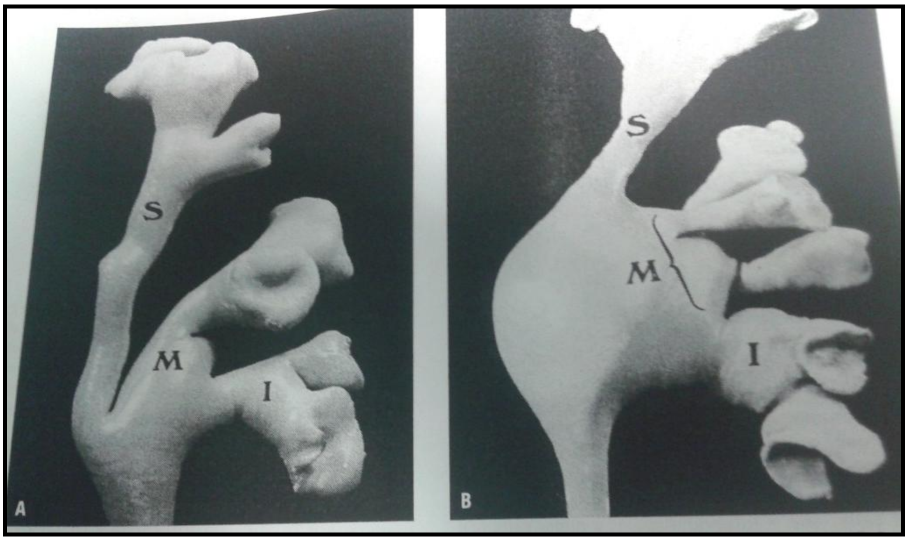

Figure (6): The two types of pelvi-calyceal system that form group B.(A) Type B-I: anterior view of a left pelvi-calyceal shows the kidney mid-zone drained by a hilar major calyx (M) independent superior (S) and inferior (I) major calyces. (B), Type B-II: anterior view of a left pelvi-calyceal shows the kidney zone drained by minor calices (M) entering straight into the renal pelvis, independent of both the superior (S) and (I) calyceal groups ***(Sampaio 1991)*.**

- **Type BII:** 16.4% the kidney mid-zone is drained by minor calyces one to four directly into the renal pelvis. Such calyces are independent of both the superior and the inferior calyceal groups ***(Sampaio 1991)*.**

Vascular anatomy of the Kidney

Arterial supply

Renal arteries typically arise from the aorta at the level of the superior margin of the second lumbar vertebral body, slightly inferior the origin of the superior mesenteric artery. The right renal artery is usually more superior and anterolateral than the left. Typically, the right renal artery has a long downward course to the relatively inferior right kidney, whereas the left renal artery has a more horizontal course to the superiorly located left kidney. The main renal arteries divide into anterior and posterior divisions that lie anterior and posterior to the renal pelvis. The anterior division branches into four segmental arteries including apical, upper, middle, and lower anterior. The apical and lower anterior segmental arteries supply the anterior and posterior surfaces of the upper and lower renal poles, and the upper and middle segmental arteries supply the remainder of the anterior surface. The posterior division supplies a large portion of the blood flow to the posterior portion of the kidney. The segmental arteries course through the renal sinus and further subdivide into interlobar arteries. At the level of the renal pyramids the interlobar arteries divide into arcuate arteries, which parallel the renal contour along the corticomedullary junction. The arcuate arteries give rise to multiple interlobular arteries. Also, the renal arteries give off inferior adrenal branches, capsular branches, and branches into renal pelvis and proximal ureter (see figure 7) ***(Beregi et al., 1999).***