ABSTRACT

PNL is the first line of treatment of renal stones >2cm according to EUA guidelines. PNL has minor complications and a high stone free rate. With advancement of flexible ureteroscopy, it becomes an option for treating renal stones with minimal complications and low hospital stay.

The aim of this work was to evaluate the efficacy and safety of both PNL and flexible ureteroscopy in treatment of renal stones.

To achieve this goal, this study was done over 30 patients with renal stones > 2cm in size. It was a double armed clinical trial with 15 patients in each arm. Patients in Group A were treated by PNL. While patients in group B were treated by flexible ureteroscopy.

Keywords

- PNL
- Percutaneous nephrolithotomy
- Kidney stone
- Flexible ureteroscopy

INTRODUCTION

The treatment for renal stone disease has changed dramatically in the last two decades with the improvements and miniaturization of instruments. Currently, shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PNL), and retrograde intrarenal surgery (RIRS) are the three main modalities for the management of upper urinary stone disease ***(Resorlu et al., 2013).***

The 2012 EAU guidelines on urolithiasis state clearly that SWL remains the method of first choice for stones <2cm within the renal pelvis and upper or middle calices. Larger stones (>2cm) should be treated by PNL or RIRS. For the lower pole, PNL or RIRS is recommended even for stones >1.5 cm because the efficacy of SWL is limited ***(Resorlu et al., 2013).***

Percutaneous nephrolithotomy (PNL) has been an essential technique for 35 yr for kidney stone removal, avoiding complications of open surgery. PNL is the first-line approach for large, multiple, or inferior calyx renal stones according to the European Association of Urology (EAU) guidelines. PNL generally is safe and effective and associated with a few but specific complications ***(Seitz et al., 2012).***

While PNL has an excellent success rate in clearing stone burden, it is invasive. The morbidity associated with PNL is acceptable for the majority of patients However, the low but significant rate of major complications include acute or partial renal loss, chronic renal failure, prolonged urine leakage, septicaemia bleeding requiring transfusion and Injury to adjacent organs (such as spleen, liver, lung, and colon) required prolonged inpatient hospital stay ***(Bader et al., 2010).***

With the advancement in endoscopic technology, a new dimension has been opened in the treatment of stone disease. Entire urinary collecting system either unilaterally or bilaterally can be reached using flexible ureteroscope; stones can be actively fragmented via holmium laser and removed by some special basket catheters. The indication of flexible ureteroscopy has been extending, including, ESWL failure, morbid obesity, musculoskeletal deformities, bleeding diathesis, and occupationsthat require complete stone clearance (i.e., pilots) ***(Alkan et al., 2014).***

Minor complication rates post retrograde holmium laser uretroscopy range from 0% to 13% and consist primarily of pain or urinary tract infection. Significant complications, including ureteral stricture, have been reported to occur in 1.5% of patients undergoing ureteroscopy ***(Bader et al., 2010).***

AIM OF THE STUDY

To illustrate the safety and efficacy of retrograde flexible ureteroscopy versus percutaneous nephrolithotomy (PNL) in management of renal stones.

Chapter One

ANATOMY

i. POSITION OF THE KIDNEYS

The kidneys lie on the posterior abdominal wall against the psoas major muscles. Their longitudinal axis parallels the lateral edges of the psoas muscle, about 30 degrees from the vertical plane, with the lower poles lateral to the upper poles. The kidneys are also tilted 30 degrees off the frontal plane, with the lower poles anterior to the upper poles. Finally, the kidneys are rotated out of the frontal plane, with the lateral aspect of the kidney is posterior to the medial aspect ***(Francisco and Sampaio, 2006).***

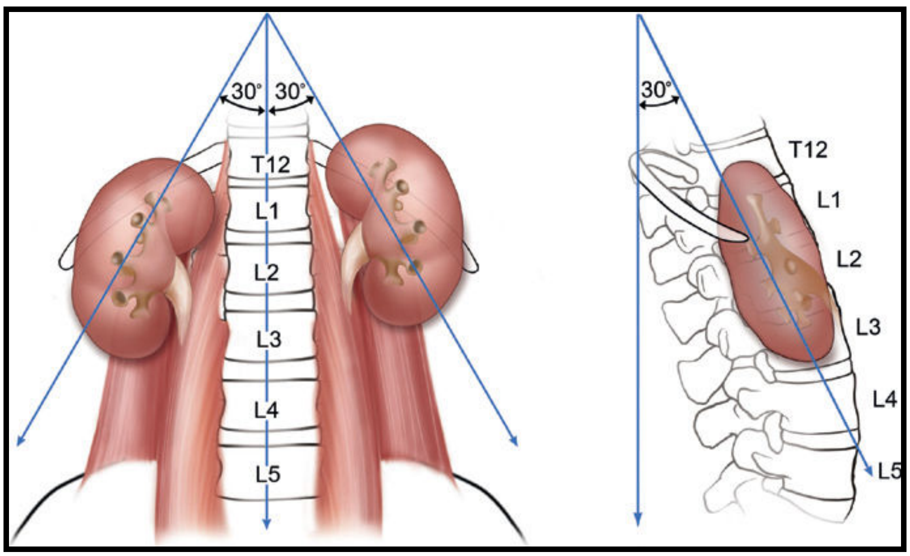

Figure (1): Position of the kidneys in the retroperitoneum Quoted from ***(Wolf, 2012).***

ii. **Renal Vasculature**

The renal pedicle consists of a single artery and a single vein that enter the kidney via the renal hilum. These structures branch from the aorta and inferior vena cava just below the level of superior mesenteric artery at the level of the second lumbar vertebra. The vein is anterior to the artery. The renal pelvis and ureter are located posterior to these vascular structures ***(Anderson and Cadeddu, 2012)***.

Arterial blood supply

Upon approaching the kidney, the renal artery splits into four or more branches. These are the renal segmental arteries. Each segmental artery supplies a distinct portion of the kidney with no collateral circulation between them. Thus occlusion or injury to a segmental branch will cause segmental renal infarction. Between these circulations is an a vascular plane (Brodel's avascular line). This longitudinal plane lies just posterior to the lateral border of the kidney. Incision within this plane results less blood loss than outside this plane ***(Francisco and Sampaio, 2006).***

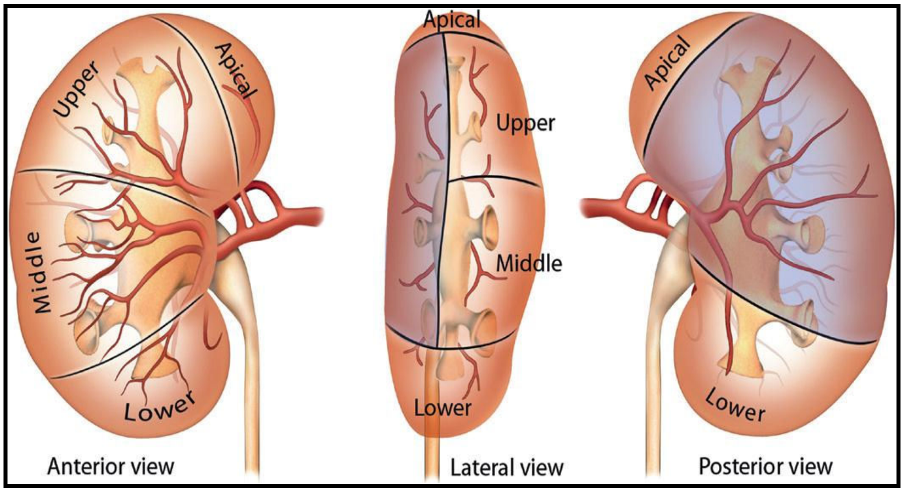

Figure (2): Showed segmental blood supply of the kidney and Brodel's line. Quoted from ***(Anderson and Cadeddu, 2012).***

Each segmental artery branches into lobar arteries, which further subdivides in the renal parenchyma to form interlobar arteries. These interlobar arteries progress peripherally within the cortical columns of Bertin, thus avoiding the renal pyramids but maintaining a close association with the minor caliceal infundibula. At the base of the renal pyramids, the interlobar arteries branch into arcuate arteries. Interlobular arteries branch off the arcuate arteries and move radially, where they eventually divide to form the afferent arterioles to the glomeruli ***(Francisco and Sampaio, 2006).***

The renal venous drainage

Correlates closely with the arterial supply. Unlike the arterial supply, the venous drainage communicates freely through venous collars around the infundibula, providing for extensive collateral circulation in the venous drainage of the kidney. Surgically, this is important because unlike the arterial supply, occlusion of a segmental venous branch has little effect on venous outflow ***(Anderson and Cadeddu, 2012)***.

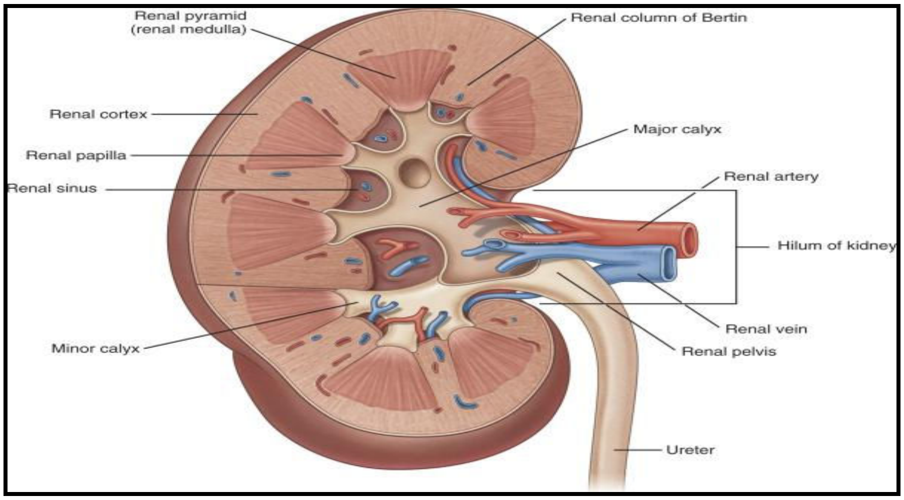

Figure (3): Intrarenal arterial anatomy quoted from ***(Drake et al., 2005).***

iii. The pelvicaliceal anatomy

The renal parenchyma consists of the cortical tissue and the medullary tissue. The renal medulla is formed by several inverted cones (pyramids). The apex of a pyramid is the renal papilla. The layers of cortical tissue between adjacent pyramids are named renal columns (cortical columns of Bertin) ***(Drake et al., 2005).***

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. Finally, the major calices drain into the renal pelvis ***(Drake et al., 2005)***.

Classification of the pelvicaliceal system

Group A

This group is composed of pelvicaliceal systems that present two major caliceal groups (superior and inferior) as a primary division of the renal pelvis and a mid zone caliceal drainage dependent on these two major groups.

Group B

This group is composed of pelvicaliceal systems that present the kidney mid zone (hilar) caliceal drainage independent of both the superior and the inferior caliceal groups ***(Francisco and Sampaio, 2006).***

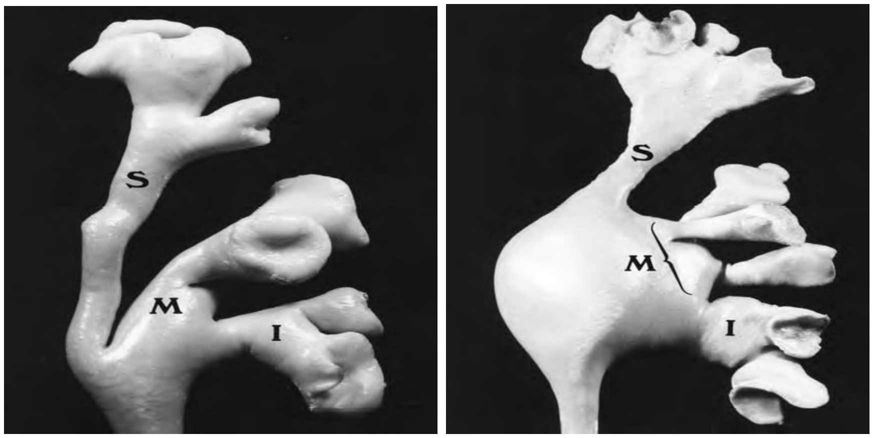

Figure (4): Group A and group B pelvicaliceal system quoted from ***(Francisco and Sampaio, 2006).***

Relation of anterior and posterior calyces to renal parenchyma

A. The Brodel-type

The posterior calyces are about 20 degrees behind the frontal plane and the anterior calyces are 70 degrees in front of the frontal plane. The posterior calyces are lateral, and the anterior calyces are medial in this case.

B. The Hodson-type

The posterior calyces are 70 degrees behind the frontal plane and appearing medial and the anterior calyces 20 degrees in front of the frontal plane and appearing lateral.

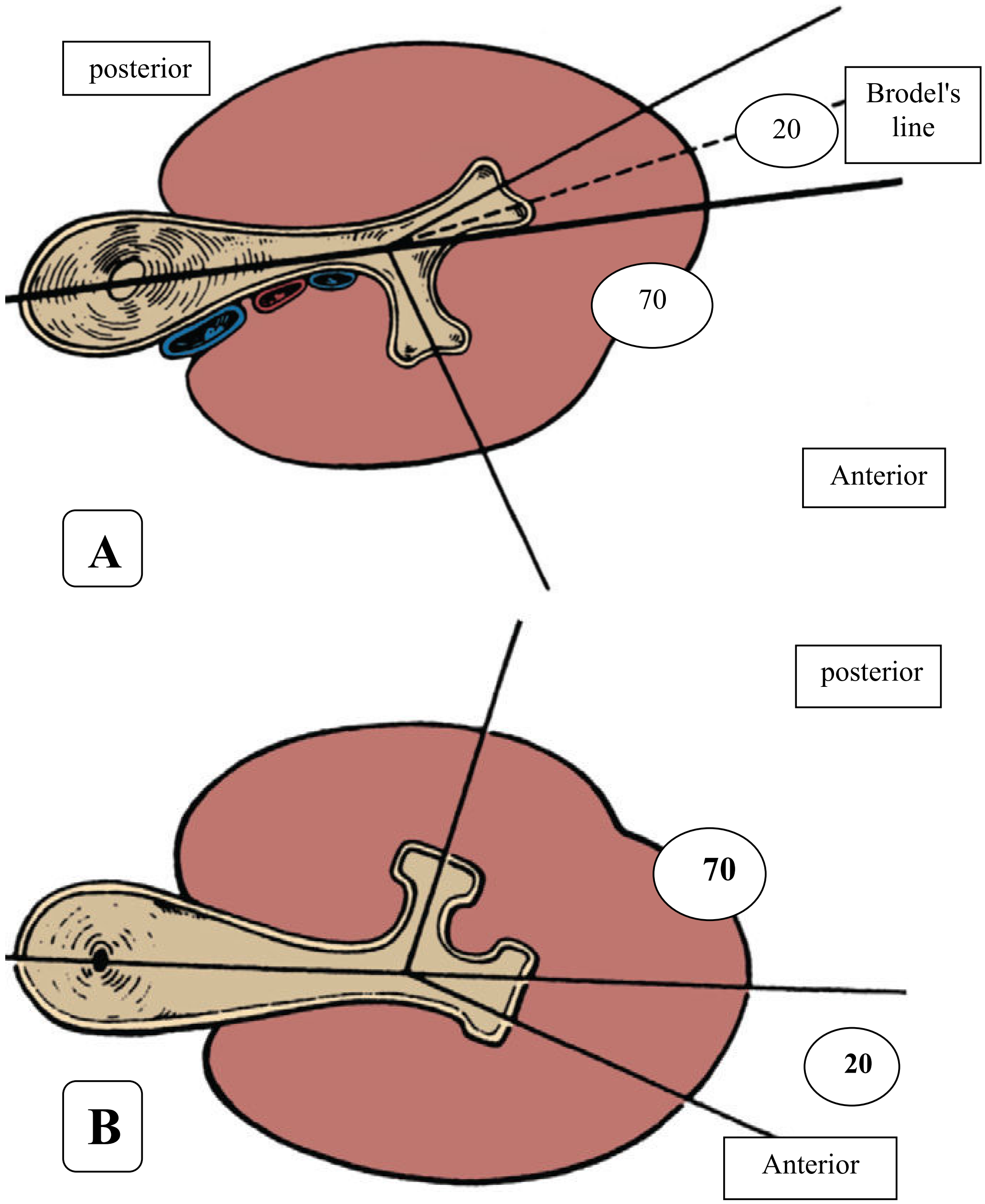

Figure (5): Relation of anterior and posterior calyces to renal parenchyma in (A) Brodel-type kidney and (B) Hodson-type kidney**.** Quoted from ***(Wolf, 2012).***

Relation between intrarenal vessels and renal calices

Upper calyx

The infundibulum of the upper calyx is completely involved with segmental arteries.

Middle calyx

The anterior aspect of the infundibulum is related to segmental arteries while the posterior aspect is related to subdivision of the posterior segmental artery.

Lower calyx

The anterior aspect of the infundibulum is related to inferior segmental artery while the posterior aspect is free from arteries ***(Francisco and Sampaio, 2006).***

Percutaneous nephrostomy through an infundibulum of a calyx is not a safe route because this type of access poses an important risk of significant bleeding from interlobar (infundibular) vessels.

Puncture and placement of a nephrostomy tube through a fornix of a calyx is safe and must be the site chosen by the operator. Even in the superior pole, the intrarenal puncture through a caliceal fornix is harmless ***(Francisco and Sampaio, 2006).***

Chapter Two

PERCUTANEOUS NEPHROLITHOTOMY

Percutaneous nephrolithotomy (PNL) was first performed in 1976. It has been used as a treatment for renal stones that cannot be dealt with by extracorporeal shock wave lithotripsy or ureteroscopy ***(Jang et al., 2011).***

i. Patient positioning

The prone position

The prone position provides a larger surface area for the choice of puncture site, a wider space for instrument manipulation, a posterior access to the collecting system through Brodel's avascular line, and a lower risk of visceral injury ***(Cecilia et al., 2011).***

Disadvantages:

1. Circulatory problems: (decreased cardiac output due to reduced venous return, reduced left ventricular compliance due to the increased thoracic pressure.
2. Ventilatory difficulties and suboptimal airway ***(Cecilia et al., 2011).***

The supine position

Advantages:

1. All the anaesthesiological disadvantages of the prone position are absent in the supine position, especially in obese patients.
2. Urologists themselves are more comfortable, sitting during the whole procedure with hands away from the fluoroscopic field.
3. The horizontal percutaneous tract and the low intrarenal pressure facilitate the spontaneous evacuation of stone fragments and minimize the possibility of their migration into the ureter.
4. Decrease fluid absorption, and thus of urosepsis ***(Cecilia et al., 2011).***

The modified supine position:

The modified supine position is a supine decubitus with arrangement of the legs in the lithotomy position. The posterior axillary line should be drawn on the skin while the patient is standing. The patient is then turned into supine position, with the flank to be operated raised and slightly rotated. The ipsilateral arm is bent on the thorax. The leg of the operated side is extended and the contralateral one is abducted. The renal puncture is made behind the posterior axillary line ***(Hoznek et al., 2011).***

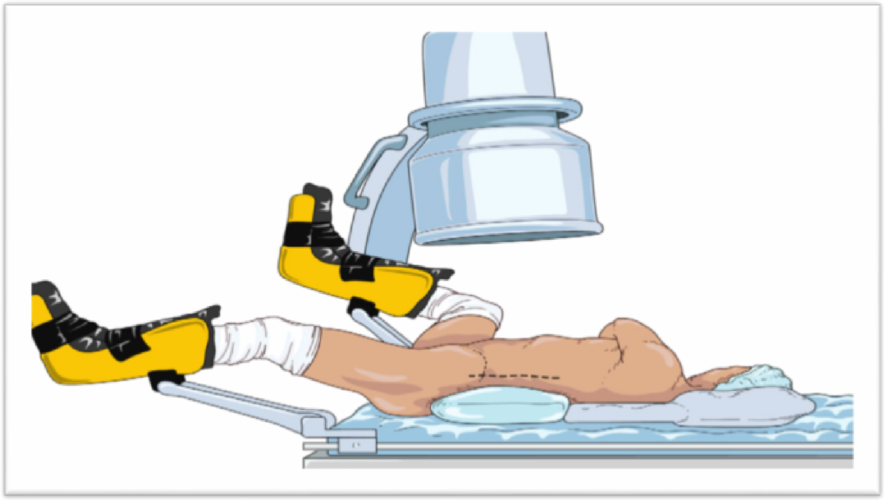

Figure (6): Galdakao-modified supine Valdivia position for percutaneous nephrolithotomy quoted from ***(Hoznek et al., 2011).***

ii. Access of PNL

The generally used accesss is the dorsal calyx of the lower pole. The puncture passes the papilla in the long axis of the target calyx avoiding contact with large vessels. Therefore, it is less traumatic and avoids major bleeding. For radiographic guidance alone, the ‘‘bull’s eye’’ technique and the triangulation technique are the most techniques used. Both require the use of a C- arm to construct a three-dimensional controllable view of the performance ***(Tepeler et al., 2012).***