Laser Versus Pneumatic Lithotripsy in Management of Renal and Ureteric Stones

<u>Thesis</u>

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Ahmed El Sayed El Sayed Hoza

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List of Abbreviations

Abbreviation	Word
AUA	American Urological Association
BMI	Body mass index
CBC	Complete blood count
EAU	European Association of Urology
EHL	Electrohydraulic lithotripsy
ESWL	extracorporeal shock wave lithotripsy
FBS	Fasting blood sugar
Ho	Holmium
HU	Hounsfield unit
INR	International normalized ratio
KUB	Kidney-ureter-bladder radiograph
LL	Laser lithotripsy
NCCT	Non-contrast computed tomography
PCNL	Percutaneous nephrolithotomy
PL	Pneumatic lithotripsy
PLL	Percutaneous laser lithotripsy
PPL	Percutaneous pneumatic lithotripsy
PTT	Partial thromboplastin time
SGOT	Serum glutamic oxaloacetic transaminase
SGPT	Serum glutamic pyruvic transaminase
UL	Ultrasonic lithotripsy
ULL	Ureteroscopic laser lithotripsy
UPJ	ureteropelvic junction
UPL	Ureteroscopic pneumatic lithotripsy
YAG	Yttrium-Aluminum-Garnet

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Introduction

Treatment of nephrolithiasis has undergone a rapid evolution over the past years due to the introduction of extracorporeal shock waves, percutaneous, and endourologic techniques which caused a shift in the management of renal stones. Percutaneous nephrolithotomy (PCNL) in combination with extracorporeal shock wave lithotripsy (ESWL) has replaced open stone surgery in most institutions (**Matlaga et al., 2002).**

PCNL has become a frequently applied surgery that leads to fewer complications, shorter durations of hospital stay, and reduced scar tissue formation**,** and has replaced open stone surgery (**Antonelli., et al., 2013).**

With advances in energy production, including the holmium: yttrium–aluminum–garnet (Ho:YAG) laser and pneumatic lithotripter, PCNL has become a safer and more efficient modality for treating stones in almost all locations of the kidney and has become the first-line therapy for kidney stones **(Mugiya., et al., 2000).**

Percutaneous nephrolithotomy represents the standard treatment for large renal stones. It is a minimally invasive procedure with high success rate and safety profile (**Rosette et al., 2011).**

Intracorporeal lithotripsy represents an essential part of the percutaneous technique. Most commonly used lithotripters are the pneumatic and ultrasonic. Pneumatic lithotripsy is more powerful than ultrasonic lithotripsy,it disintegrates the stone into multiple different sized pieces that require extraction by forceps or a basket. Moreover, these pieces can migrate to a remote calyx resulting in residual stones. Ultrasonic lithotripsy has a simultaneous suction property so it simultaneously fragments stones and clears the resulting fragments. The holmium laser is now used for intracorporeal lithotripsy. It has the ability to fragment any type of calculi into fine fragments with minimal retropulsion and the laser fiber can pass through any type of endoscope. Therefore, it becomes the best device for ureteroscopic disintegration of upper ureteric and intrarenal calculi. The holmium laser was used for disintegration of renal calculi during PCNL **(Gu Z., et al., 2010).**

The introduction of smaller flexible and semi rigid ureteroscopes has led to safer and more effective methods of treatment. So, ureteroscopy (URS) has become one of the most important techniques in the management of urinary lithiasis.With an increase in efficacy and a reduction in complications, URS is now considered to be a primary choice for management of ureteral stones **(Bader MJ., et al., 2012).**

Treatment of ureteral calculi has evolved from open ureterolithotomy to minimally invasive procedures such as extracorporeal shock wave lithotripsy, ureteroscopic lithotripsy and laparoscopic lithotomy. Among them, ureteroscopic lithotripsy holds the minimal contraindications, nearly available for all except severe ureteral stricture preventing successful scope passage. Ureteroscopic interventions become the main therapeutic way for large ureteral stones due to high stone-free rate and low complications. **(Razzaghi MR., et al., 2013).**

Minimally invasive techniques for the treatment of ureteral stones should be evaluated from the standard points of efficacy and the ultimate success rate of the various procedures. These include the feasibility of the procedure, number of the sessions required to render the patient stone-free, complication rate and the requirements to achieve the stone-free status. However, advances have been made in ureteroscopes and lithotripsy techniques such as laser lithotripsy and pneumatic lithotripsy have increased the success rates and decreased the complications of even large stones (**Wu et al., 2005).**

With the development of small diameter semi-rigid and flexible ureteroscopes and the availability of Holmium YAG laser, the success rate of treating proximal ureteral stones has markedly improved to greater than 90% using small diameter ureteroscopes**(Slam and Tricia, 2002).**

Energy source is required to disintegrate the stone into manageable fragments. The options available are ultrasonic lithotripsy, electrohydraulic lithotripsy, pneumatic lithotripsy and laser lithotripsy. Since the HO:YAG laser was introduced into clinical practice in 1990, it has been successfully used in different urologic conditions and has been accepted to be an effective and safe treatment modality for the endoscopic management of urolithiasis. The holmium: YAG laser energy produces smaller fragments than pneumatic energy or electrohydraulic source (**Jou Y., et al., 2005).**

Some authors favor using laser lithotripsy, due to it's advantages on fragmentation and flexibility. However, other authors think that pneumatic lithotripsy is comparable to laser lithotripsy in fragmentation efficiency, accompanying the advantage of low cost and easy installation **(Akdeniz E., et al., 2014).**

Aim of the Work

The aim of this work is to compare between laser lithotripsy and pneumatic lithotripsy via ureteroscopy and percutaneus nephrolithotomy in management of upper ureteric and renal stones.

Chapter 1
Anatomy

Anatomy of the Pelvicalyceal System:

Understanding the collecting system anatomy is of a great importance for appropriate radiologic interpretation and performance of different endourologic procedures (**Elkoushy M., 2016).**

Position of the kidneys:

The kidneys are paired ovoid, reddish-brown retroperitoneal organs situated in the posterior part of the abdomen on each side of the vertebral column. The longitudinal axes of the kidneys are oblique with the upper poles more medial and posterior than the inferior poles. The medial aspect of each kidney is rotated anteriorly at an angle of approximately 30 degrees. The exact position of the kidney within the retroperitoneum varies during different phases of respiration, body position and presence of anatomic anomalies (**Elkoushy M., 2016).**

The kidneys lie adjacent to vertebral bodies, extending from the 11th or 12th thoracic to the 2nd or 3rd lumbar vertebrae (Fig. 1). The right kidney is lower few centimeters than the left kidney. The longitudinal axes of the kidneys are parallel to the lateral edges of the psoas muscles. Each kidney is rotated 30 degrees posteriorly from the renal hilum (**J.Stuart Wolf, Jr., 2012).**

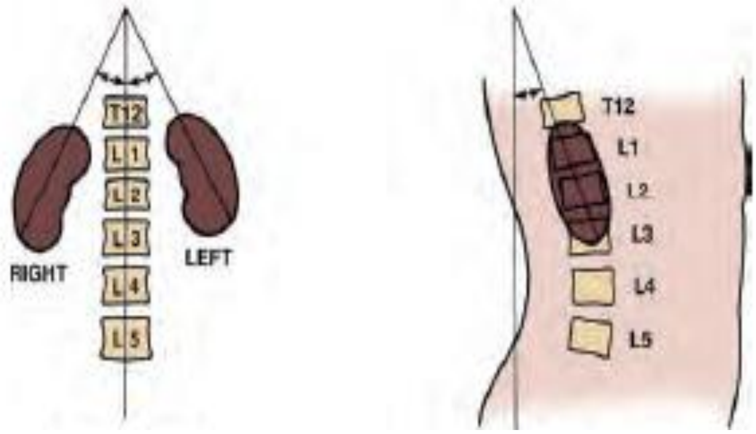

Fig.(1): Location of kidney in retroperitoneum
(**J.Stuart Wolf, Jr., 2012).**

The anatomy of pelvicalyceal system is variable, Fig. (2), and there is no simple rule defines its organization. The renal pelvis is roughly pyramidal, with its base facing the parenchyma and its apex funneling down into the ureter. The renal pelvis may be intrarenal pelvis which is completely imbedded within the renal sinus or extrarenal pelvis which is mostly outside it. The pelvicalyceal system may have the configuration of a true pelvis which is the classic type in which the calyces drain directly through elongated necks into an elongated pelvis or divided double calyceal pelvis. The renal calyx is a concave structure with two side projections, the fornices, which surround the papilla of the renal medulla. Each kidney contains an average of 7 to 9 calyces, although this number may vary from 4 to 19 or even more (**Elkoushy M., 2016).**

The upper pole of the kidney usually contains three calyces and less commonly two, while the interpolar region may contains three or four calyces and the lower pole contains two or three calyces. These calyces vary in numbers, size and shape because of the different numbers of papillae they receive. A calyx may receive one papilla, two, or even three. Compound papillae are often found in the polar regions of the kidney. The upper pole is usually drained by a single midline calyceal infundibulum, while the lower pole is drained by either a single midline calyceal infundibulum or by paired calyces. The hilar region is drained by anterior and posterior rows of paired calyces (**Elkoushy M., 2016).**

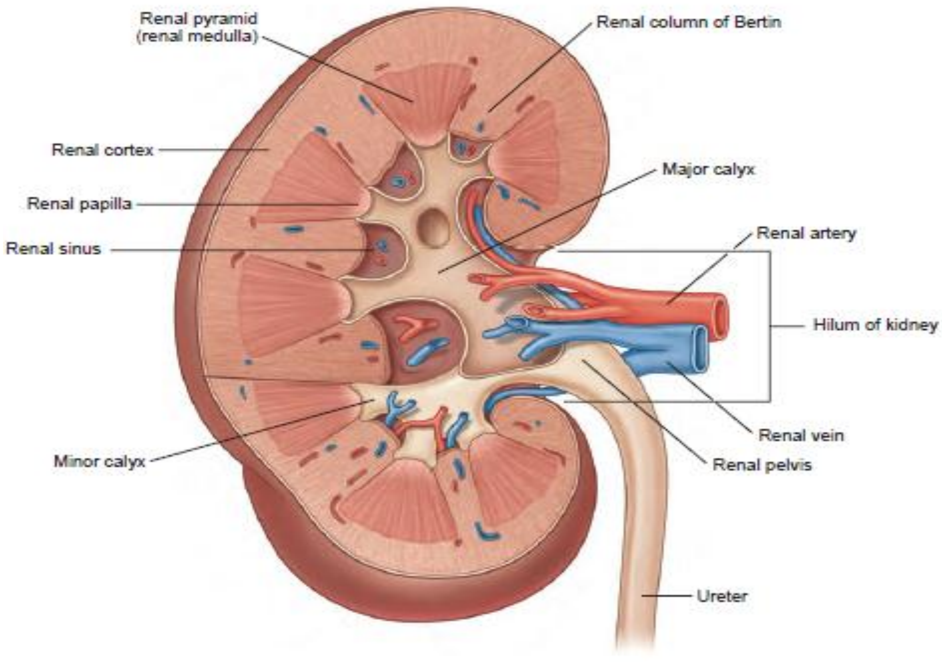

Fig.(2): Internal structure of the right kidney**(RL. Drake.,et al., 2005)**

<u>Endoscopic Anatomy of the Ureter:</u>

The ureters are bilateral muscular retroperitoneal tubes with narrow lumen. Each ureter runs inferiorly as a continuation of the renal pelvis at the ureteropelvic junction(UPJ), situated lateral to the tips of the transverse