INTRODUCTION

Urinary calculi is the third most common affliction of the urinary tract, exceeded only by urinary tract infections and the pathological conditions of the prostate. The prevalence of urinary tract stone disease is estimated to be 2-3% ***(Jiang et al., 2008).***

Patients with urolithiasis constitute an important part of everyday urological practice. The optimal clinical management of this disease requires knowledge of the diagnostic procedures, the rational treatment of acute stone colic, stone expulsive treatment and the modern principles of stone removal ***(Tiselius et al., 2011).***

The primary goal of complete stone clearance for the management of proximal ureteral stones is to preserve renal function, prevent further stone growth, cure infection, and relieve obstruction ***(Wolf, 2007).***

There are various options in the management of proximal ureteral stones, which includes medical expulsive therapy, extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (URS; retrograde), percutaneous nephrolithotomy (PCNL), laparoscopy (LAP), and open surgery ***(Türk et al., 2014)***.

Before the year 1980, open ureterolithotomy was being performed widely, nowadays in the management of ureteral stones ESWL (Extracorporeal Shock Wave Lithotripsy) and endoscopic interventions are preferred ***(Khaladkar et al., 2009).*** Open

ureterolithotomy is no longer considered as a valid option in a well equipped endourological center ***(Maislos et al., 2004).***

Nowadays, extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy (URS) are the most commonly performed treatment options in the management of proximal ureteral stones. Although the European Association of Urology (EAU) urolithiasis guidelines showed that both URS and ESWL should be considered as a first-line therapy for proximal ureteral stones, the optimal treatment of these stones still remains debatable ***(Türk et al., 2014)***.

In proximal ureteral stones smaller than 1cm, ESWL constitutes the first treatment alternative. However, difficulties encountered during visualisation of the stone, presence of impacted and/or calcium oxalate monohydrate and cystine stones, actual health state of the patient lower the success rates of ESWL and lead to preference of URS in such cases ***(Salem, 2009).***

Ureteroscopes can be classified by their performance characteristics into rigid, semirigid and flexible types ***(Basillote et al., 2004).***

In recent years, the advent of smaller-caliber semirigid ureteroscopes (4.5 and 6 Fr) and advances in efficient intracorporeal lithotriptors such as electrohydraulic, ultrasonic, pneumatic and holmium laser have resulted in high success and low morbidity rates. Pneumatic lithotripsy (PL) was first introduced in the early 1990s ***(Hong and Park, 2009).***

Introduction of holmium laser into the market and worldwide accepted use of this laser during ureteroscopy (URS) makes the stone clearence rates better even for the stones up to 20mm ***(El-Nahas et al., 2012).***

With the advancements in the designs of ureteroscopes, stone disintegration systems and endourologic techniques, most of the kidney stones and large proximal ureteral stones can be managed by flexible ureteroscopy (F-URS) nowadays ***(Bas et al., 2014).***

Narrow working channel of the flexible URS that force the manipulation of auxiliary instruments and higher procedural costs can be mentioned among the main restrictions of the flexible URSs. However, in cases where safe use of rigid and semi-rigid ureteroscopes is impossible or in the situation of stone migration into intrarenal collecting system, flexible URSs remain the optimal option ***(Nerli et al., 2011).***

Types of intracorporeal lithotripsy:

- Electrohydraulic lithotripsy (EHL)
- Ultrasonic lithotripsy (USL)
- Pneumatic lithotripsy (PL)
- Laser lithotripsy (LL)

(Sun et al., 2001)

Types of laser in urology:

Currently in the urology practice Nd: YAG laser, Holmium: YAG(Ho: YAG) laser, Thulium:YAG (Tul: YAG)

laser, carbon dioxide (CO_2) laser, potassium titanyl phosphate (KTP) laser, lithium triborate (LBO) laser, and diode laser have been used ***(Zarrabi and Gross, 2011)***.

Among them, currently Ho: YAG laser lithotriptor is the most prevalently used ureteroscopic lithotriptor in the world**.** ***(Lee and Gianduzzo, 2009)*** Ho: YAG laser was essentially developed for prostatic surgeries, and it is used in the names of some endoscopic prostate surgeries including HoLAP (Holmium laser ablation of the prostate), and HoLRP (Holmium laser resection of the prostate).

The most conspicuous advantage of Ho: YAG laser lithotriptors include its capability of disintegrating all stones irrespective of their compositions into smaller fragments when compared with other lithotriptors, and lower risk of stone migration into renal collecting system because of weaker shock waves.

European Association of Urology (EAU) recommends Ho: YAG laser lithotripsy as a gold standard procedure for ureteroscopic intracorporeal lithotripsy ***(Lam et al., 2002).***

Aim of the Work

To compare the clinical outcome of semirigid ureteroscopy and flexible ureteroscopy in management of upper ureteric stones using laser lithotripsy regarding to stone clearance rate, success rate, time factor, complications cost benefits.

Chapter 1

ANATOMY OF THE URETER

Anatomicaly, The ureter refers to the hollow viscus that conveys the urine formed in the kidney to the urinary bladder. In the normal adult, the ureter is 25–30-cm (10–12 inches) long with a 4–5-mm caliber ***(Smith et al., 2012).***

The ureter does not follow a straight course from the renal pelvis to the urinary bladder, but more of an S-shaped course in both sagittal and transverse planes ***(Walsh, 2002).***

The ureter runs caudal and medial in front of the psoas muscle, enters the bony pelvis, and terminates within the urinary bladder wall at the ureterovesical junction (UVJ). Its opening into the urinary bladder can be visualized endoscopically at the ureteral orifice.

For purpose of accurate location of various pathology along the course of the ureter and for further discussion or planning of certain interventional procedures, the ureter is divided into three segments:

- Upper ureter: relates to the ureteral segment that lies between the UPJ and the pelvic brim;
- Mid ureter: relates to the ureteral segment that extends from the upper to the lower border of the sacral bone;

- Lower ureter: relates to the segment that lies between the lower border of the sacrum and the ureteral orifice ***(Anderson et al., 2007).***

An alternative nomenclature divides the ureter into the abdominal ureter, i.e. the segment that runs along the psoas muscle to the level of the iliac vessels ("*pars abdominalis*"), and the pelvic ureter, i.e. the segment that runs within the pelvic cavity from the level of the iliac vessels down to the urinary bladder ("*pars pelvina*").

These two segments represent the proximal and the distal ureter, respectively ***(Smith et al., 2012).***

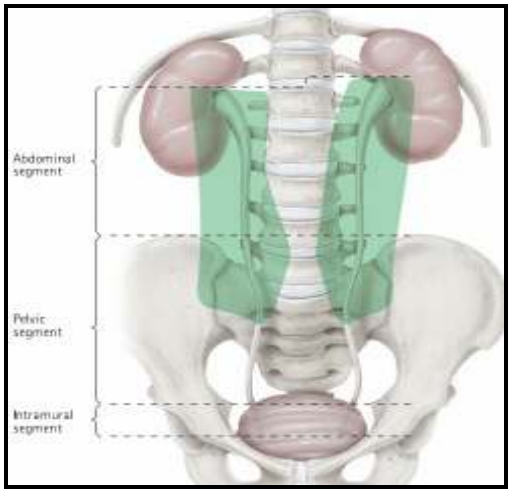

Figure (1): Parts of the ureter**.**

Endoscopically, a normal ureter is relatively uniform in caliber and easily distensible; however there are three naturally occurring relatively narrow sites within the lumen that are

recognizable endoscopically: The uretropelvic junction, the pelvic brim region(the crossing over the iliac vessels), and the uretrovesical junction ***(Anderson et al., 2007).***

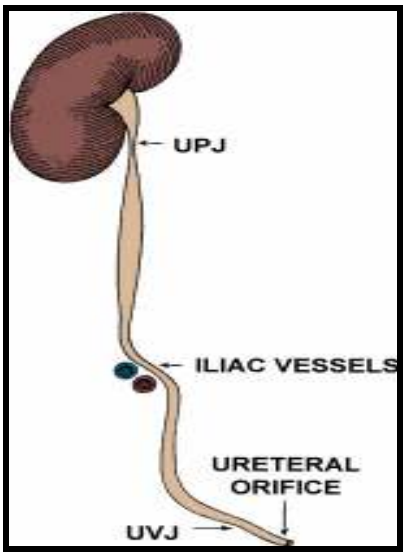

Figure (2): Areas of relative narrowing.

The narrowest part is the vesico ureteral junction, This requires dilation before introduction of large caliber instruments The other two narrow area are at the pelvic brim and the pelvi ureteral junction. These are relatively wider and are sufficiently dilated with irrigating fluid pressure to allow instrument passage. These areas are identified endoscopically by a slightly stenotic appearance and relative non distensibility. Furthermore, the pelvic brim constriction is at the area of the iliac vessels, which can be seen pulsating behind the ureter as this level is approached. Following this is a relatively straight section where the middle of the ureter lies on the psoas muscle.

It is here that the typical stellate appearance of the non distended ureteral lumen can be discerned. This leads to the third constriction at the pelvi ureteral junction, which is identified endoscopically as a narrowing in the ureter followed by the wide renal pelvis. A postero lateral lip of mucosa is sometimes seen in this region. It corresponds to the junction of the ureter with the more dependent part of the pelvis and is accentuated with the respiratory movements" ***(Abdel-Razzak, 2006).***

Chapter 2

CLASSIFICATION OF URINARY STONES

Classification of stones

Urinary stones can be classified according to the following: stone size, stone site, radio density of stone, etiology of stone formation, stone composition and risk groups for recurrent stone formation ***(Turk et al., 2011).***

i. Stone size

The size of a stone is usually given in millimeters, using one or two dimensional measures. Stones can be classified further into those measuring up to 5 mm, >5-10 mm, >10-20 mm, and >20 mm ***(Turk et al., 2011).***

ii. Stone location

A stone can be classified according to its anatomical site in the urinary system at diagnosis: upper calyx, middle calyx, lower calyx, renal pelvis, upper ureter, middle ureter or lower ureter, urinary bladder and urethra ***(Turk et al., 2011).***

iii. Stone radio density

A stone can be classified according to its appearance on plain X-ray (KUB: kidney-ureter-bladder radiograph), which varies according to its mineral composition. If non-contrast

computed tomography is used, Hounsfield Units (HU) provide information on stone density and stone composition ***(Kim et al., 2007).***

Table (1): Plain X-ray characteristics ***(Kim et al., 2007).***

Radiopaque	Poor radiopaque	Radiolucent
Calcium oxalate dihydrate	Magnesium ammonium phosphate	Uric acid
Calcium oxalate monohydrate	Apatite	Ammonium urate
Calcium phosphates	Cystine	Xanthine
		2,8-dihydroxyadenine
		'Drug-stones'

iv. Etiology of stone formation

Stones can be classified into those caused by infection and those not caused by infection (i.e. infection-stones and non-infection stones), stones arising from genetic defects, and stones formed as a drug side-effect (i.e. 'drug stones') ***(Turk et al., 2011).***

Table (2): Stones classified according to their etiology ***(Turk et al., 2011).***

Non-infection stones
▪ Calcium oxalates
▪ Calcium phosphates
▪ Uric acid
Infection stones
▪ Magnesium-ammonium-phosphate
▪ Apatite
▪ Ammonium urate
Genetic causes
▪ Cystine
▪ Xanthine
▪ 2,8-dihydroxyadenine
Drug stones
▪ Indinavir stones

v. Stone composition:

Metabolic aspects play an important role in stone formation and a metabolic evaluation is required to rule out any disorder. Additionally, a correct stone analysis in relation to any metabolic disorders helps in diagnostic and management decisions.

Stones are often made from a mix of different substances. The substance forming the largest part(s) of the stone is considered to be the most important ***(Turk et al., 2011).***

Table (3): Stone composition ***(Turk et al., 2011).***

Chemical composition	Mineral
Calcium oxalate monohydrate	whewellite
Calcium-oxalate-dihydrate	wheddelite
Uric acid dehydrate	Uricite
Ammonium urate	
Magnesium ammonium phosphate	struvite
Carbonate apatite (phosphate)	dahllite
Calcium hydrogenphosphate	brushite
Cystine	
Xanthine	
2,8-dihydroxyadenine	
Drug stones	

vi. Risk groups for stone formation

The risk status of a stone former is of particular interest as it defines both probability of recurrence of stones and mandatory for pharmacological treatment. About 50% of all recurrent stone formers have one recurrence during lifetime. Highly recurrent disease is observed in more than ten percent of all stone formers. Stone type and severity of disease are the determinants which define the patient to be at low risk or at high risk for stone recurrences ***(Straub et al., 2005).***

Table (4): High risk stone formers ***(Straub et al., 2005).***

General factors
• Early onset of urolithiasis in life (especially children and teenagers)
• Familial stone formation
• Brushite containing stones (calcium hydrogen phosphate; CaHPO4 . 2H2O)
• Uric acid and urate containing stones
• Infection stones
• Solitary kidney (The solitary kidney itself does not have a particular increased risk of stone formation, but the prevention of a potential stone recurrence is of more importance)
Diseases associated with stone formation
• Hyperparathyroidism
• Nephrocalcinosis
• Gastrointestinal diseases or disorders (i.e. jejuno-ileal bypass, intestinal resection, Crohn's disease, malabsorptive conditions)
• Sarcoidosis
Genetically determined stone formation
• Cystinuria (type A, B, AB)
• Primary hyperoxaluria (PH)
• Renal tubular acidosis (RTA) type I
• 2,8-dihydroxyadenine
• Xanthinuria
• Lesh-Nyhan-Syndrome
• Cystic fibrosis
• Drugs associated with stone formation
Anatomical and urodynamic abnormalities associated with stone formation
• Medullary sponge kidney (tubular ectasia)
• Ureteropelvic junction (UPJ) obstruction
• Calyceal diverticulum, calyceal cyst
• Ureteral stricture
• Vesico-uretero-renal reflux
• Horseshoe kidney
• Ureterocele
• Urinary diversion (via enteric hyperoxaluria)
• Neurogenic bladder dysfunction

Chapter 3

DIAGNOSIS OF URETERIC STONES

i. Symptoms

The most commonly occurring leading symptom is radiating colicky pain in the hypochondrium. The pain varies depending on the position of the stone in the ureter and may attain excruciating intensity. The worst pain is caused by high-lying concretions located in the costovertebral angle ***(Fisang et al., 2015).***

The Pain associated with ureteral calculi often projects to corresponding dermatomal and spinal nerve root innervation regions. The pain of upper ureteral stones thus radiates to the lumbar region and flank. Mid ureteral calculi tend to cause pain that radiates caudally and anteriorly toward the mid and lower abdomen in a curved, band-like fashion. This band initially parallels the lower costal margin but deviates caudal toward the bony pelvis and inguinal ligament. The pain may mimic acute appendicitis if on the right or acute diverticulitis if on the left side, especially if concurrent gastrointestinal symptoms are present ***(Marshall et al., 2008).***

ii. Metabolic evaluation

Each patient with urolithiasis needs a succinct biochemical work-up of urine and blood besides the imaging