

## Effect of ureteric stone location on the success rate of ureteroscopic Holmium laser lithotripsy

Mohamed F. Ahmed\*

MBCChB, FICMS

Asaad I. Othman\*\*

MBCChB, FICMS

Uday H. Mohammad\*\*\*

MBCChB, FABMS, FJMC

### Summary:

**Background:** Ureteral stone can cause obstructive uropathy and subsequent deterioration of renal function. There are four treatment options for ureteral calculi: lithotripsy, ureteroscopy, laparoscopic ureterolithotomy, and open stone surgery. Holmium YAG laser is an excellent intracorporeal lithotripter for all kinds of stones. Accordingly, there is steady increase in number of ureteroscopic laser lithotripsy operations in the management of Ureteral stone.

**Objectives:** this study was designed to demonstrate the effect of ureteric stone location on the success rate of ureteroscopic Holmium laser lithotripsy in the management of ureteric stones.

**Patients and Methods:** Ninety middle-aged patients of either sex ( $35.9 \pm 10.8$  years) with ureteric stone ( $9.5 \pm 3$  mm) were treated with semirigid ureteroscopy using Holmium: YAG laser as an intracorporeal lithotripter. In 32 patients (35%) the stone were located in the lower ureter, 22 patients (24%) in middle ureter and in 36 patients (40%) in the upper ureter. Then all the patients were followed up on day 1 and 4 weeks for clearance of stone by plain abdominal radiography and abdominal ultrasonography.

**Results:** the stone free rates 4 weeks after the treatment were 66% for upper, 75 % for middle and 87.5% for lower ureteric stones. In 12 patients (13%) cannot be possible to reach the stone, six patients (6.6 %) had proximal stone migration and treated later on by extracorporeal lithotripsy after double-J stent placement. Ureteral perforation occurred in 7 patients (7.7%), all managed by double-J stent placement except 1 patient needed an open surgical treatment.

**Conclusion:** YAG laser lithotripsy is efficacious modality of treatment for ureteric stones especially in lower ureter and it is a safe and technically feasible and in early experience, it is preferred to start with more distal stones.

**Key words:** Ureteric stone, Ureteroscopy, Holmium YAG lithotripsy.

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### Introduction:

Urinary calculi have serious implication in urology. Ureteral stone can cause obstructive uropathy and subsequent deterioration of renal function [1]. There are five treatment options for ureteral calculi: 1) extracorporeal shockwave lithotripsy (ESWL), 2) open stone surgery (OSS), 3) percutaneous nephrolithotomy (PNL), 4) laparoscopic ureterolithotomy (LUL), and 5) ureteroscopic procedures [2]. The advancement of ureteroscopy and related working instrument to manipulate or fragment ureteral calculi have significantly increase treatment options for urologist [3]. Endoscopic interventions aimed at stone fragmentation utilize electro hydraulic, ultrasonographic, pneumatic and laser [ruby, carbon dioxide, neodymium: yttrium–aluminum garnet (Nd: YAG), dye, alexandrite and holmium: yttrium–aluminum–garnet (Ho: YAG)] energy sources [4]. The ruby laser—developed by Mulvaney and Beck in 1968 was the first laser capable of fragmenting stones [5]. Since that

time, many other lasers have been used for lithotripsy with varying degrees of success [6]. The Holmium YAG laser can fragment all types of stones with an ablative effect, removing portions of the stones as dust like particles during the fragmentation procedure. This allows treatment without any residual particles [7]. The mechanism of Holmium YAG lithotripsy is photothermal. It heats the stone to a critical thermal threshold at which the stone composition is altered yielding a stone crater and small fragment. Pressure waves from Holmium YAG lithotripsy are less as compared with other types of lithotripsy methods, yet some retropulsion occur. It has more successful and safer endoscopic removal of ureteric stones with best stone free rate, but the total treatment charge are more expensive than other energies [8, 9]. This study presents the results of patients with ureteric stone treated with ureteroscopic Holmium:YAG laser lithotripsy in the urology unit at Aljamhory Teaching Hospital in Mosul where this technology is recently introduced since two years and to see the impact of stone location in the ureter on the stone free rates.

\*Dept. of Surgery, Ninevah College of Medicine/ University of Mosul.

\*\*Urologist, Ministry of Health, Aljamhory Teaching Hospital Mosul.

\*\*\*Dept. of Surgery, Mosul College of Medicine/ University of Mosul.

**Patients and methods:**

Between September 2011 and December 2012, 90 patients who were diagnosed by specialist urologist as a cases of ureterolithiasis (proximal, middle or distal ureteral stone(s)) were treated with ureteroscopy using Holmium: YAG laser as an intracorporeal lithotripter at the department of urology, Aljamhory Teaching Hospital in Mosul. Radiolucent stones excluded from the study because of difficult follow up by simple KUB. Some of these patients failed to respond to medical conservative expulsive therapy using Tamsulosin cap .4 mg once daily. All patients had preoperative assessment with detailed history and physical examination, Laboratory tests that include; hematocrit, BUN, serum creatinine, urinalysis and, if necessary, urine culture. Preoperative ultrasonography (US), intravenous pyelography or spiral CT were done in all patients to document the size and site of the stone.

On performing ureteroscopic laser lithotripsy, the following equipments were considered at our unit:

- 9.5 Ch. semi-rigid ureterorenoscope with a 43 cm length.
- 8.5 Ch. semi-rigid ureterorenoscope with a 34 cm length.
- 3-5 Ch. ureteral catheters.
- 2.7 Ch. Dormia baskets.
- Reusable Ho laser fiber with diameters of 600µm.
- A Ho: YAG laser device (AurigaXL).

Interventions were made under general anesthesia. Preoperative antibiotic prophylaxis was used whenever pyuria was detected. The patients were positioned on the operating table in a lithotomy position with the leg stretched on the affected side and raised on the opposite side (Perez-Castro position). Video monitoring and an endocamera were used in each case. While fluoroscopy considered only whenever needed. Distilled water was used as a perfusate. After placement of guide wire and negotiation of the ureteric orifice, the ureteroscope advanced to reach stone location. If the stone could not be trapped with a stone basket, it was fragmented as much as possible until fragment less than 2 mm, The Ho: YAG laser device was set to 0.8-1.2 J and 5-10 Hz frequency. In case of complete clearance of fragments a JJ stent may inserted for few days. In cases where the ureteral opening can't be penetrate or the stone can't be reached or the stone pushed back, a JJ stent inserted for further extracorporeal shock wave lithotripsy (ESWL). Postoperatively all patients underwent abdominal plain radiography. They were followed up with plain radiography and renal ultrasonography after four weeks also. The operation was deemed successful when the patient was totally free from existing stones and unsuccessful in case of proximal migration of the fragments or when the ureteroscope could not be reaching the stone.

**Statistics:**

All statistical analysis was performed using SPSS, version 16 (Descriptive statistics) in addition to Microsoft Office Excel.

Discrete variable presented as numbers and percentages.

**Results:**

As shown in table 1; all the patients' selected (90 patients) are involved in this study (56 males (62.2%) and 34 females (37.7 %)). The age of patients range between 15 -55 years with a mean of (35.9 ± 10.8). Concerning stone location and size, 60 % of the stones locate in the left side with a stone size of 9.5 ± 3 mm (6 -20 mm). Moreover, in 36 patients (40%), the stone locate in the upper ureter, 22(24%) in the middle ureter and 32(35%) in the lower ureter. Failure to access the ureteral orifice occurred in 8 patients and failure to reach the stone in 4 patients, in both cases a JJ stent was placed and patients sent for ESWL. Stone migration occurred in 6 patients all of them are upper ureteric stones. A JJ stent were introduced into the ureter after lithotripsy in 52 patients (57%), most of them after upper ureteric stones (33.3%), while (13 %) after middle and (11%) after lower ureteric stones. The overall stone free rate are (51%) at first day after the procedure, and (77.7 %) after 4 weeks. According to stone location, the stone free rate at first day are 31% for upper, 54% for middle, 75% for lower ureteric stones. Whereas, after 4 weeks 66% for upper, 81.8% for middle and 87.5% for lower ureteric stone as shown in figure 1, however it is statistically not significant (p< 0.05 ). Complications (table 2), like stone migration which mainly occurred in cases with upper ureteric stone, perforation of ureteral wall occurred in 7 patients which is minor and treated by insertion of a JJ stent except for one patient who need open surgery as large perforation. While, 5 patients suffer Haematuria that persist for more than 2 days.

**Table1: Demographic and characteristics data of the studied groups.**

<b>Patients(n):</b>	<b>90</b>
<b>Sex (n):</b>	
<b>Men</b>	<b>56 (62%)</b>
<b>Women</b>	<b>34 (37%)</b>
<b>Age (years)</b>	<b>35.9 ± 10.8 (mean ± SD)</b>
<b>Stone treated (n)</b>	<b>90</b>
<b>Stone location(n):</b>	
<b>Upper ureter</b>	<b>36(40%)</b>
<b>Middle ureter</b>	<b>22(24%)</b>
<b>Lower ureter</b>	<b>32(35%)</b>
<b>Stone size(mm):</b>	
<b>Mean ± SD (overall)</b>	<b>9.5 ± 3</b>
<b>upper ureter</b>	<b>9.6 ± 2.2</b>
<b>middle ureter</b>	<b>9.2 ± 1.5</b>
<b>lower ureter</b>	<b>9.5 ± 4.3</b>

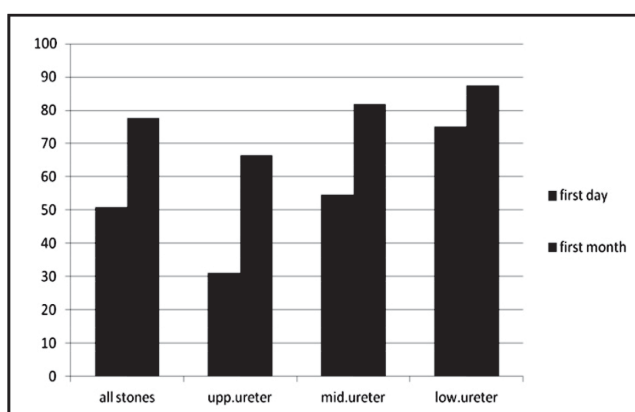


Figure 2: stone free rate stratified by stone location (%). (p > 0.05)

Table 2: complication of the Holmium: YAG laser intraracorporeal lithotripter.

Complication	number	%
Stone migration	6	6.6
Perforation	7	7.7
Hematuria more than two days	5	5.5

**Discussion:**

The development of fiber-optic technology and several methods of ureteroscopic fragmentations have greatly expand the treatment options for ureteral calculi in different locations [10]. After advances in ureteroscopic devices, lithotripsy techniques and surgical experience, ureteroscopic lithotripsy ( URSL) has become a more common and an effective treatment modality in the management of ureteral stones with high fragmentation rates and minimal tissue trauma [11, 12, and 13]. It offers safe and successful clearance of stones rendering the majority of patients stone-free after one session which is the ultimate goal of this technology that is to achieve complete stone-free status with minimal morbidity. Locations of the stone are important factors for a successful procedure. A high success rate has been reported for the ureteroscopic treatment of distal ureteral stones, but the results in proximal ureteral stones vary [14, 15]. For this reason some authors prefer ureterorenoscopy as a primary treatment in middle and distal ureteral stones [16,17]. Marberger et al., 1994 reviewed a large series (over 2,000 patients) of ureteral stones and found that distal ureteral stones were better treated by an endoscopic procedure [18]. In various studies, the success rates of URSL in proximal stones were reported between 88 and 98% [19, 20, 21]. Moreover, As a result of the analysis of the reported files, the stone-free rates of URSL were in the range of 70–90.9% (proximal),

88–92% (the middle) and 83–98.6% (distal) according to the stone location [22, 23, 24]. Subsequently, it was found that our stone-free rates according to stone location were 66.6 (24/36) in the proximal ureter, 81.8% (18/22) in the middle ureter and 87.5% (28/32) in the distal ureter. Since the success rate of URSL depends on stone size, location, availability of ureteroscopic instrumentation and experience of surgeon [25,26]. However, the results of this study are generally lower than what was published in the literatures mentioned due to many factor, first of all it is an early experience in this procedure in our unit with the limited facilities such as absent ureteric dilator and stone graspers and cone catheters that prevent stone migration during the fragmentation. the lower success rates concerning the upper portion of the ureter are closely related to difficulties in introducing the device and stone migration and have nothing to do with the inefficiency of the laser beam, Cheung et al. reported that semi rigid -URS with Holmium: YAG laser lithotripsy was safe and effective for treating calculi at all levels in an outpatient setting with success rate of 93%.( 27). Although using the Holmium Laser lithotripsy is expensive and not available in many centers, the use of pneumatic lithotripsy instead of Holmium laser is not appropriated due to high probability of stone migration which may reach to 14% in some study. Regarding complication, the safety of ureteroscopic interventions has been questioned in various studies and as a result the general agreement is that ureteroscopy is a rather safe and almost never leads to ureteral stenosis in the long term [28]. The fact that a Holmium YAG laser beam is absorbed by fluid has its advantages that beyond certain distance (1 mm) neither perforate nor damage the wall of the ureter. In various studies ureteral perforation has been observed in 4–9% of the cases [17, 29], which go with our result and in most of these patients the preferred and adequate treatment had been ureteral stent drainage. Some considered stone migration to higher levels during ureteroscopy is not a complication because of the subsequent possibility of treating the stone with ESWL [30]. However failure of the procedure due to stone migration is still found in 5–18% of the cases [28]. In our series stone migration occurs in 6.6% (6 / 90) which is also within the recorded values. Stone migration or retropulsion is minimal with Ho laser, but still reported which is due to rinsing water used especially when the impacted stone causing proximal dilatation and when the stone near the pelve ureteric junction. Failure of ureteroscopic advancement has been reported in literature in 5 to 25% of the patients [16] which go with our report, and so with respect to prolonged hematuria. Accordingly, the complications are in accordance with the current literature. The principles of placement of a ureteral catheter after ureteroscopic lithotripsy are to prevent ureteral strictures and to reduce the incidence of post-operative renal

colic secondary to ureteral edema [29, 30]. However, after uncomplicated cases, most urologists found it is unnecessary to place a ureteral catheter [14]. In this study, JJ stent inserted in 52 patients out of 90 (57%) most of them due to inability to access and stone migration in upper ureteric stone. The common problem related to JJ stent placement in patient group was minor such as mild irritative bladder symptom and hematuria.

#### Conclusion:

Holmium: YAG laser lithotripsy is efficacious modality of treatment for ureteric stones in all locations, the final determinant of success is not the Ho laser itself but other technical factor like failure of access and stone retropulsion especially in upper ureter. Accordingly, in early experience it is preferred to start with more distal stones

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