# Evaluation of Holmium YAG laser Lithotripsy in Ad-Diwaniyah Teaching Hospital

**Ali Hamdan Fahad*,Mohammed Ali Gadhban*,**
**Montadhar Hameed Nima****

## ABSTRACT:

**BACKGROUND:**

In this study we evaluate the efficacy and safety of ho:yag laser lithotripsy via rigid ureteroscopy as primary treatment modality of ureteric ston in our institute stones parameters,stone free rates and complications rates were evaluated

**OBJECTIVE:**

To evaluate holmium YAG (yttrium aluminum garnet) laser lithotripsy via semi rigid ureteroscope in management of ureteric calculi in Ad-Diwaniyah teaching hospital.

**METHODS:**

From October 2013 to October 2014, 100 patients with ureteric calculi were included in this study. Calculi were approached with 9.5 Fr. Semi rigid ureteroscope and fragmented with holmium YAG laser system (Stone light AMS).

The following parameters were assessed: success, failure, and complications rates in addition to patient's age, sex, stone size and site. Cases of failure of introduction of the ureteroscope or those with small stones retrieved by grasper only were excluded from the study. Termination of the procedures because of perforation or retropulsion were considered as failure.

**RESULTS:**

Sixty five males and 35 females were included with a mean age of (39±3) years (range 20-60). Fifty eight patients (58%) had lower ureteric stone, 25 patients (25%) had mid ureteric stone and 17 patients (17%) had upper ureteric stone. Mean stone size was 10.61 mm (range 7-20mm).

Overall success rate was 96% which was more for the lower than upper ureteric stone. Failure occurred in 4 patients (4%), 2 of them due to retropulsion and the other 2 patients due to ureteric perforation.

Apart from ureteric perforation and retropulsion, complications were minor and were amenable to conservative treatment.

**CONCLUSION:**

Holmium YAG laser lithotripsy is a minimally invasive, highly effective safe method for treatment of ureteral calculi.

**KEY WORDS:** ureteric stones, ureteroscopy, holmium yag laser lithotripsy.

## INTRODUCTION:

Urinary stone disease is a major health care problem due to its high prevalence and incidence. The disease is very common among both men and women, stones form twice as often in men as in women with estimated prevalence among the population of 2 to3% and an estimated lifetime risk of 12% for white males and 5–6% for white females. Despite an improved understanding of the mechanisms of stone formation it is obvious that ureteral stones are still a problem afflicting an increasing number of patients worldwide. [1, 2]

Most ureteral calculi pass spontaneously and do not require intervention. Spontaneous passage depends on stone size, shape, location and associated ureteral edema (which is likely to depend on the length of time that a stone has not progressed).

When interventional therapy is indicated (table 1) the optimal interventional therapy for patients requiring removal of distal ureteral calculi is controversial. Perhaps the greatest dilemma facing the urologist today is to choose between the two most frequently used modalities in ureteral stone treatment—ESWL and ureteroscopy. ESWL and ureteroscopy are both effective treatments associated with high success rates and limited morbidity, ESWL is preferred for treatment of upper and mid ureteric stone more than ureteroscopy that is preferred for lower ureteric stone. [2, 3, 4]

*Diwaniya Teaching Hospital.
**Baghdad Medical College.

**Table 1:Indications for interventional therapy** [2, 4]

| |
|---|
| 1. stone diameter ≥ 7mm. |
| 2. Inadequate pain relief. |
| 3. Uncomplicated distal ureteral stones ≤10 mm that have not passed after 4-6 weeks of observation, with or without MET |
| 4. Risk of pyonephrosis or urosepsis. |
| 5. Bilateral obstruction, or obstruction in a single kidney. |
| Pediatric patient and pregnant failed to respond to MET. |

Ureteroscopy for treatment of large ureteral calculi need intracorporeal lithotripter. [5]

**Types of Lithotripters:**

Four types are available for intracorporeal lithotripsy: laser, electrohydraulic (EHL), ultrasonic and ballistic lithotripsy. These can be divided into flexible (laser lithotripsy and EHL) and rigid (ultrasonic and ballistic lithotripsy). [4]

**Laser Lithotripsy**

The first laser lithotrite was the pulsed-dye laser, which employed a coumarin green dye as the liquid laser medium with a wavelength of 504 nm. Calculi throughout the urinary system were fragmented, with success rates of 80% to 95% reported except cystine calculi. [4, 6, 7]

Technologic advancements eventually led to the development of the holmium: YAG laser that operates at a wavelength of 2140 nm in the pulsed mode. The zone of thermal injury associated with laser ablation ranges from 0.5 to 1.0 mm. The holmium: YAG laser can transmit its energy through a flexible fiber, which facilitates intracorporeal lithotripsy throughout the entire collecting system. Successful fragmentation of ureteral stones of all compositions has been reported in 91% to 100% of cases, with low risk of perforation and retropulsion. The major disadvantage of the holmium laser is the initial high cost of the device and the cost of the laser fibers. [8, 9, 10]

## AIM OF THE STUDY:

To evaluated the efficacy and safety of holmium: YAG laser lithotripsy via a semirigid ureteroscopy for fragmentation of ureteric stone in Ad-Diwaniyah teaching hospital.

## PATIENTS AND METHODS:

From October 201٣ to October 2014, 100 patients (65 male and 35 female) with ureteral stones were admitted to Al-Diwaniyah teaching hospital, urology unit and enrolled in this study, their age range from 20 to 60 years with a mean age of 39±3 years.

All patients were evaluated by history, physical examination, laboratory investigations (including urinalysis, full blood count and renal function tests). The stone size, location, opacity and degree of obstruction were assessed by preoperative radiographic imaging studies, including KUB, ultrasound and computerized tomography (CT scan).

In seventeen patients, the stones were located in the upper ureter, whereas in 25 patients the stones were in the mid ureter and the remaining (58 patient) had lower ureteric stones. The mean calculi sizes was 10.61±3.6 mm (range from7 mm to 20 mm). In 85 patients the stones were radiopaque while in 15 patients they were radiolucent.

The patients were selected on the bases of standard indications for interventions for ureteric stone. The operations were done under general anesthesia in 85 patients and under spinal anesthesia in the others. All patients received a single dose of broad spectrum parenteral antibiotic at the time of induction of anesthesia.

Our equipment were:

1. The Holmium YAG laser lithotripsy system (AMS stone light system) wavelength of 2100nm.
2. A 550 -_µ reusable laser fiber.
3. A 9.5 Fr. KARL STORZ semi rigid ureteroscope with 5 Fr. working channel and $6^0$ lens.
4. A 0.035- inch guide wire (Polytetrafluoroethylene (PTFE) coated guide wire).
5. Hand-inflated pressure bag.
6. Camera and video system.
7. Normal saline (0.9% sodium chloride) as irrigation fluid.

Patients were placed in standard lithotomy position; the ureteroscope was passed into the ureter with aid of a 0.035- inch guide wire (Polytetrafluoroethylene (PTFE) coated guide wire) in most of the patients without a need for ureteral dilatation. Cases of failure of introduction of the ureteroscope were managed by DJ stenting and were excluded from our study. In the same way small stones retrieved by graspers only without the need for laser lithotripsy were excluded from our study too. Continuous low-pressure fluid flow was

necessary to maintain visibility. Laser energy generally was applied at an initial setting of 0.6 J at a pulse rate of 3 Hz and raised incrementally by 0.2 J as necessary. The maximum power that used was 5 W and the maximum pulse rate was 5 Hz.

We fragment the stones into small non-significant fragments supposed to pass spontaneously. Stone gravels usually passed down along the flow of irrigation fluid. Large fragments were removed with grasper.

Post URS DJ stent placement was done only in cases of:

1. Long time procedure (>45 min).
2. Ureteral injury.
3. Single kidney.
4. Impacted stone.
5. Cases of retropulsion.

A 5Fr. DJ stent was inserted and left indwelling for 4 weeks in17 patients. For those patients, KUB was taken at the same or next day. Foley's catheter were inserted in most of our patients especially in those with DJ insertion, Foley's catheters were removed at the same night or next morning except in cases with perforation or hematuria where it kept longer. Parenteral antibiotics were continued for 2 days, and replaced by oral antibiotics for 5-7 days. Most of our patients were discharged on the first postoperative day.

The stents were removed after 4 weeks using 22Fr Karl Storz rigid cystoscopy under topical urethral anesthesia.

All patients who suffered from ureteral perforation underwent intravenous pyelography 4 weeks after removal of ureteral stent in order to rule out any ureteral stricture or hydronephrosis.

## RESULTS:

The total number of our patients was 100. They were treated by ureteroscopy and intracorporeal holmium YAG laser lithotripsy for distal, mid and lower ureteric calculi. They were 65 males and 35 females and their age ranged from 20 to 60 years with a mean age of ٣٩±3 years (table ٣). The parameters of treated stones in our patients were illustrated in (table 4).

Most of our patients (96%) were stone free after a single ureteroscopic procedure. The stone-free rate stratified by stone location was 100% in the distal ureter, 92% in the midureter and 88% in the proximal ureter (table 7).

The mean operative time (the time from the start of the ureteroscopy to the end of the procedure), was 31.1 minutes (range 20–60 minutes).

Treatment failure occurred in 4 patients (4%), the causes were either retropulsion in 2 of them or ureteral perforations in the others.

At the end of the operation 5Fr. DJ stents were used in 17 patients (17%). They were indicated due to either prolong operative time ( more than 45 min) in 9 patients or retropulsion in 2 patients or perforations in 4 patients or due to single kidney in 2 patients as shown in table (5).

Intraoperative complications encountered in 6 patients (6%), in a form of retropulsion (2 patients) and perforation (4 patients). Postoperative complications were minimal and illustrated in (table 6). The average hospitalization time was 24 to 48 hours.

**Table 2: Postoperative complications.**

| complications | No. | % |
|---|---|---|
| Hematuria | 8 | 8% |
| Dysuria | 52 | 52% |
| Flank pain | 12 | 12% |
| High grade fever | 3 | 3% |

**Table 3: Stone-free rate stratified by stone location.**

| Site | NO. of Patients | Stone free rate |
|---|---|---|
| Lower third | 58 | 100% |
| Middle third | 25 | 92% |
| Upper third | 17 | 88% |

## DISCUSSION:

The management of ureteral calculi represents one of the complex problems in urological practice. In planning to treat ureteral calculi, several factors are to be considered simultaneously, including stone size, chemical composition, location of the stone, anatomy of the urinary tract and the impact on the renal function, which are all depend on the availability of modern efficient radiological investigation. On the other hand available treatment modalities should also considered and need to be evaluated for their efficacy, cost and morbidity. All these considerations make the management of ureteral calculi uniquely challenging. [11, 12]

Fortunately, during the past two decades, a variety of new therapeutic modalities have been developed with the aim of providing effective treatment and at the same time minimizing the unpleasant effects of therapy. Accordingly, ureteric calculi are primarily approached by ESWL or ureteroscopy and several devices are available for achieving intracorporeal stone destruction which includes electrohydraulic (EHL), laser, ultrasonic and pneumatic (ballistic) lithotripters. [13, 14, 15, 16, 17, and 18]

The technique of holmium laser lithotripsy is relatively straightforward and involves placing the fiber on the stone surface before activating the laser. Lithotripsy depends on the pulse energy output and the diameter of the optical delivery fiber, implying that lithotripsy efficiency correlates with energy density. [19, 20]

In this study we evaluate the efficacy and safety of holmium: YAG laser lithotripsy via semi rigid ureteroscopy for treatment of ureteric stones, which is the primary treatment modality in Ad-Diwaniyah teaching hospital in the last three years. [21, 22]

Our fragmentation time range from 20 to 60 minutes with a mean of 31.10 minutes which was comparable to Zibigniew Purpuiowicz et al and Salman A. Tipu et al who were reported a mean operative time of 38.4 minutes and 39.6 minutes respectively. [23, 24]

Our overall success rate was 96%, the success rate in the lower ureter was 100% while in the midureter was 92% and in the upper ureter was 88%.

Our overall success rate and success rate of different site of the ureter was comparable to that achieved by other studies which were ranged from 90.9% to 96 %. [23, 24, 25.26.27]

The lower stone free rate for middle and upper ureter than the lower ureter was due to intraoperative complications; retropulsion and perforations.

Retropulsion is possibly an unavoidable problem for calculi in the upper ureter, which occurred in 2 of our patients. Migration of the stone up into the pevicaliceal system is secondary to high-pressure irrigation and increased pulse energy of laser. The distance of calculi from the ureteropelvic junction seems to be important when attempts are made to minimize retropulsion such as using low-pressure irrigation and decreased pulse energy of laser at time of lithotripsy which are the techniques to reduce retropulsion. The use of Dormea basket and occlusive balloon catheter are another techniques to prevent retropulsion. We applied ESWL for displaced stones, and it proved to be a good complementary option. Retropulsion described in many other studies with a rates of 1.3%- 7%. [23, 24, 27, 28]

Ureteric perforation can be caused by the ureteroscope, guide wire, or laser energy. The risk of perforation from laser energy is negligible, because the depth of thermal injury is only 0.5 to 1 mm. [28, 29, and 30]

Ureteric perforations in our patients were due to ureteroscope and guide wire equally. Perforations rate in our study was (4%) which was approximately the same rates that observed in other studies concerning laser lithotripsy which ranged from 2.6%-6 %. [23, 24]

However successful fragmentation completed in 2 cases with lower ureteric stone in spite of perforation that occurred by the guide wire at the beginning of the procedure.

Ureteral stenting is the best management of perforation [23, 24]. The stenting was performed in those patients with perforation directly through the working channel of the ureteroscope and was kept for 4 weeks. Ultrasonography were done 4 weeks after removal of the stent to detect any ureteral stricture and hydronephrosis in those patients. IVU was performed to those patient with abnormal ultrasonography.

Some authors suggest that, in cases where stone fragmentation takes longer than 45 minutes, a stent should be placed, because ureteric edema and temporary post-operative obstruction may be more likely to occur than with shorter procedures. [31]

In our study, the procedure time was more than 45 minutes in 9 cases (9%) and 5Fr. DJ stents was left in situ to avoid obstruction.

The complications are not specific for laser lithotripsy and can occur following any ureteroscopy. These complications were comparable to that reported by other studies [23, 24].

In comparison to ESWL, the success rate of ESWL for upper, mid and lower ureteral stones reported by 2 Iraqi studies were 70%, 76.9% and 77.5%. [32, 33] while our success rates were 8^%, 92% and 100% for upper, mid and lower ureteral stone respectively.

In comparison with pneumatic lithotriptripsy, our successful fragmentation rate for upper, mid and lower ureteral stones was better than that achieved by pneumatic lithotripsy which was 72.72%, 87.50% and 95.23%. [33]

In addition laser lithotripsy has less proximal migration than pneumatic lithotripsy which was 12% as reported by Ikram Ullah et al. ([34] This is because weak shock waves. Furthermore, the probes for laser lithotripters are more suitable for smaller caliber instruments which make it more favourable over pneumatic lithotripter in addition to its simplicity, reliability, and ease to use for urologists. The only disadvantage of this energy source seems to be the cost of the device and probes. [13]

## CONCLUSION:

Laser lithotripsy is a safe procedure associated with few complications which were minor and amenable for conservative treatment.

## RECOMMENDATIONS:

1. We recommend using holmium: YAG lithotripsy via semirigid ureteroscopy for all patients with ureteric stone asking for single shot treatment.
2. Holmium: YAG lithotripsy is recommended as a primary treatment option for impacted lower ureteric stones as it is more effective than ESWL.
3. We recommend using holmium YAG laser lithotripsy at low level of frequency and low flow pressure to avoid retropulsion in cases of upper ureteric stones.
4. We recommend further studies with larger sample size for more accurate results.

## REFERENCES:


1. Whitfield H. The management of ureteric stones. Part II: therapy. *BJU Int* 1999;84:916–21.
2. Stefanos Papadoukakis, Jens-Uwe Stolzenburg, Michael C. Truss: Treatment Strategies of Ureteral Stones. Eau - EBU update series 2006;4:184- 190.
3. Stoller ML: Urinary Stone Disease. Smith's General Urology, 2008;17th Ed:246-77.
4. Ben H. Chew, John D. Denstedt: Ureteroscopy and Retrograde Ureteral Access. Campbell-Walsh Urology, 2007;9th Ed: 1000-10.
5. Artur H. Brito, Anuar I. Mitre, Miguel Srougi: Ureteroscopic Pneumatic Lithotripsy of Impacted Ureteral Calculi. International Braz J Urol, 2006;32: 295-99.
6. Ben H. Chew, MD, MSc, FRCSC John D. Denstedt, MD, And FRCSC: Ureteroscopy and Retrograde Ureteral Access in Alan J. Wein, MD, PhD (Hon) et al: Campbell-Walsh Urology, 2007;9th ed.:1000-10.
7. Preminger GM, Tiselius H, Assimos DG, et al: 2007 Guidelines for the management of ureteral calculi. J Urol, 2007;178: 2418.
8. Pearle MS, Nadler R, Bercowsky E, et al: Prospective randomized trial comparing shock wave lithotripsy and ureteroscopy for management of distal ureteral calculi. *J Urol* 2001;166:1255-60.
9. Rasool M., Tabassum S.A., Mumtaz F., et al: Experience of Ureteroscopic Pneumatic Lithotripsy In Management of Lower and Mid Ureteric Calculi. ANNALS 2008;14.
10. Bagley DH, Kuo RL, Zeltser IS: An update on ureteroscopic instrumentation for the treatment of urolithiasis. *Curr Opin Urol*, 2004;14:99-106.
11. O'Toole Gc, Khan SM, Kelly DG, et al: The management of ureteric calculi without extracorporeal shock wave lithotripsy. Ir Med Sci., 2000;169:119-21.
12. Joel Teichman, MD. Smith's text book of endourology, 2007;2nd ed:37- 40.
13. Leveillee, Raymond J.; Lobic, Leonid: Current opinion in Urology. May 2003;13 - issue 3: 249 - 53.
14. Demetrius H. Bagley: Ureteroscopic Lithotripsy in Diagnostic and Therapeutic Endoscopy. *J Endourol*. 1997; 4:1-7.
15. Weimin Yu, Fan Cheng, Xiaobin Zhang, et al: Retrograde ureteroscopic treatment of upper ureteral stones: A 5-year retrospective study. J. Endourology 2010; 24:1753-57.

**16.** Gurbuz ZG, Gonen M, Fazlioglu A, et al: Ureteroscopy and pneumatic lithotripsy followed by extra-corporeal shock wave lithotripsy for treatment of distal ureteral stones. Int J Urol 2002;9:441-44.

**17.** Delvecchio FC, Kuo RL, Preminger GM.: Clinical efficacy of combined lithoclast and lithovac stone removal during ureteroscopy. *J Urol*, 2000;164:40-42.

**18.** Akhtar MS and Akhtar FK.: Utility of the lithoclast in the treatment of upper, middle and lower ureteric calculi. Surg JR Coll Surg Edinb Irel, 2003:144-48.

**19.** Patrick C., Alan B., E. Darracott Jr., and Alan J. Campbell's urology textbook. Tenth edition 2010;Chapter 45: 1359-61.

**20.** Grasso M, Bagley D. French actively deflectable, flexible ureteroscope: A new device for both diagnostic and therapeutic upper urinary tract endoscopy. Urology 1994;3:435–41.

**21.** Wollin TA, Denstedt JD. The Holmium Laser in Urology. J Clin Laser Med Surg 1998;6:13–20.

**22.** Vassar G.J, Teichman JM, and Glickman RD. Holmium: YAG lithotripsy efficiency varies with energy density. J Urol 1998;160:471–76.

**23.** A.M.Abdel Latif : Ureteroscopic Holmium YAG Lasertripsy For Treatment Of Impacted Ureteral Calculi , African Journal of Urology 2007;13:262 – 66.

**24.** Zibigniew Purpuiowicz, Mark Sosnowski: Endoscopic Holmium Laser Treatment for Ureterolithiasis, Central European Journal of Urology 2012/65/1: 24 – 27.

**25.** JD Kelly, PF Keane et al: Laser Lithotripsy for Ureteral Calculi: results in 250 patients, the ulster medical journal, 1995; 64:126 – 30.

**26.** Salman A. Tipu, Hammad A. Malik, Nazim M.,.et al: Treatment of Ureteric Calculi - Use of Holmium: YAG Laser Lithotripsy versus Pneumatic Lithoclast. Sindh Institute of Urology and Transplantation (SIUT), Karachi Vol. 57, No. 9, September 2007:400-2.

**27.** Johnson DE, Cromeens DM, Price RE. Use of the holmium: YAG laser in urology. Lasers Surg Med 1992;2:353–63.

**28.** Nishioka NS, Domankevitz Y, Flotte TJ, et al. Ablation of rabbit liver, stomach, and colon with a pulsed holmium laser. Gastroenterology 1989;96:831–37.

**29.** Santa-Cruz RW, Leveillee RJ, Krongrad A. Ex vivo comparison of four lithotripters commonly used in the ureter: What does it take to perforate? J Endourol 1998;12:417–22.

**30.** Lio Ding Yi, He Hong – Cho et al: Ureteroscopic Lithotripsy Using Holmium Laser for 187 Patients with Proximal Ureteral Stone, Chinese Medical Journal 2012;125:1542 -46.

**31.** Al-Azzawi-I-S.: Impacted lower ureteric stones: the treatment options currently available. Iraqi J of community medicine, 2004;17: 400-4.

**32.** Al-Azzawi-I-S. : Treatment of ureteric stones by in .situ ESWL. Iraqi postgraduate medical J., 2002;2: 63-66.

**33.** Ikram Ullah et al: Evaluation of Safety and Efficacy of Ureteroscopic Lithotripsy in Managing Ureteral Calculi: Ann. Pak. Inst. Med. Sci. 2011;7:119 – 22.

**34.** Knoll T, Alken P, Michel MS. Progress in management of ureteric stones. Eur Urol Update Series 2005;3:44-50.