Efficacy of Holmium: Yag Laser in Ureteric Stone Fragmentation

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ABSTRACT:

BACKGROUND:

Urolithiasis is a common presenting condition in urologic daily practice, 20% are ureteral stones. The most commonly performed procedures were shock wave lithotripsy (SWL) and ureteroscopy using holmium: YAG laser that can fragment all types of calculi.

OBJECTIVE:

Here we provide our experience with the use of holmium: YAG laser in the treatment of ureteric stones as fragmentation rather than complete vaporization aiming to decrease the operative time and subsequent complications.

MATERIALS AND METHODS:

In this prospective study, 54 patients with ureteric stones were treated using Holmium:YAG laser as an intracorporeal lithotripter in Fallujah general hospital between November 2009 and July 2011, using a 9.5 Fr. storz-semirigid ureteroscope. Stones were diagnosed by excretory urography, or spiral computerized tomography. We estimated the time of operation starting from the onset of application of laser on stone till complete clearance or termination of the procedure. Stone forceps retrieval of stone fragments was done. Double J ureteric stent was placed in complicated cases only. Postoperatively all patients were followed up with plain radiography and renal ultrasonography.

RESULT:

Fifty four patients with ureteric stone were included, their ages range from 19 to 60 years. Complete clearance of the stones was achieved in 38 cases (70.4%). The intraoperative complication was reported in 17 (31.5%) as upward stone migration in 6 cases (11.1%), ureteric perforation only once (1.9%) and bleeding in 10 cases (18.5%). Postoperative complications were infection in 59.3%, urinoma in 1.9% and hematuria in 13%. Complete clearance was 75%, 64.7% and 66.6% in distal, mid and proximal ureter respectively. Stones with sizes less than 1cm, 1-2cm and those with multiple stone the clearance were 81.4%, 65.2% and 25% respectively. The operative time was less in distal stones and in stone size <1cm. Intraoperative complications were higher with longer operative time, while perforation only occurred once when the operative time prolonged >30 min. Postoperative complications were higher with longer operative times, while urinoma complicating perforation occurred in one case when the operative time were more than 30 minutes

CONCLUSION:

Our clinical results, especially with respect to complication rates and outcome, advocate the trial of fragmentation with stone retrieval rather complete vaporization to shorten the operative time and subsequent complications.

***KEYWORDS*:** ureteric stone, holmium LASER.

INTRODUCTION:

Urolithiasis is a common presenting condition in urologic daily practice. The lifetime risk for urinary stone disease is estimated at 5–12% in Europe and the USA, affecting 13% of men and 7% of women [1,2]. Of all types of urinary system stones, 20% are ureteral stones, and almost 70% of these are distal ureteral stones [3]. The optimal choice of ureteral stones management depends on various factors, including stone size, composition, location, patient characteristics, and available equipment. The most commonly performed procedures were shock wave lithotripsy (SWL) and ureteroscopy (URS)[4].

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Urologic endoscopy was initiated with quite simple instruments in 1806 [5]. During the following one and a half centuries big steps forward had been experienced. In recent years the advent of small caliber ureteroscopes and advances in intracorporeal lithotripsy, such as ultrasound, pneumatic, electrohydraulic, Neodymium:YAG laser, Pulsed Dye laser and most recently the Holmium:YAG laser, have allowed more successful and safer endoscopic removal of ureteral calculi[6,7]. A high success rate has been reported for the ureteroscopic treatment of distal ureteral stones, but the results in proximal ureteral stones vary [8,9,10,11,12,13].

The mechanism of holmium: YAG laser lithotripsy is photothermal [14]. Holmium: YAG energy heats the stones to a critical thermal threshold at which the stone composition is altered, yielding a stone crater and small fragments, thereby minimizing upward stone migration[15]. The holmium: YAG laser can fragment all types of calculi. It fragments stones with an ablative effect, removing portions of the stone as dust-like particles during the fragmentation procedure. This allows the treatment of calculi without any residual particles[16].

AIM OF STUDY:

Here we provide our experience with the use of holmium: YAG laser in the treatment of ureteric stones as fragmentation rather than complete vaporization aiming to decrease the operative time and subsequent complications.

MATERIALS AND METHODS:

In this prospective study, 54 patients with a diagnosis of ureteric stones were treated using Holmium:YAG laser as an intracorporeal lithotripter in Fallujah general hospital between November 2009 and July 2011,

This study included cases with obstruction of the upper urinary tract due to the presence of ureteral stone that was bigger than 6 mm in diameter. Ureteroscopy using Holmium:YAG laser (LISA LASER/ GERMANY) as an intracorporeal lithotriptor was performed , using a 9.5 Fr. storz-semirigid ureteroscope. All the operations were carried out under general or regional anesthesia.

Stones were diagnosed by excretory urography, or spiral computerized tomography. The ureters were divided into three (proximal, middle and distal).

All the patients were maintained on prophylactic antibiotics before ureteroscopy. After the cystoscopy, guide wire was introduced into the ureter. By the access of guide wire, balloon dilatator or olive tipped dilatators inserted through the ureteral orifice and sufficient ureteral dilatation was performed. We estimated the time of operation starting from the time of application of laser on stone till complete clearance or the procedure aborted

The Holmium:YAG laser frequency was between 6 and 10 Hz, and pulse energy was 1 J. The majority of the patients were treated with optical core 365 μm quartz fiber. Stone forceps retrieval of stone fragments was done. After Holmium:YAG laser lithotripsy double J ureteric stent was placed in complicated cases only.

Postoperatively all patients were followed up with plain radiography and renal ultrasonography. The operation was considered successful when the patient was totally free from existing stones and unsuccessful in case of proximal migration of the fragments or when the stone could not be destructed completely.

The statistical package for social sciences (SPSS-17) software was used for data analysis of all the findings in this study. Chi squared test was performed, and p values less than 0.05 were considered significant for differences.

RESULT:

Fifty four patients with a diagnosis of ureterolithiasis were included, their ages range from 19 to 60 years with mean of 34.7 ± 9.74 SD years. There were 33 man (61.1%) and 21 (38.9%) women. The stones were localized in the distal ureter in 28 patients (51.9%), middle part in 17 patients (31.5%) and proximal ureter in 9 patients (16.7%). Stones size of less than 1cm were 27 (50%),1-2cm were 23(42.5%) and multiple ureteric stones were only 4 (7.5%).

The outcome of operation was either complete clearance of the stones that was achieved in 38 cases (70.4%) or incomplete clearance including those stones that could not be dealt with them due to intraoperative complications were 16 (29.6 %) . The intraoperative complication were reported in 17 cases (31.5%) as upward stone migration occurred in 6 cases (11.1%), ureteric perforation only once (1.9%) and bleeding in 10 cases (18.5%). On the other hand postoperative complications were infection in 14 cases (59.3%), urinoma in one case (1.9%) and

hematuria in 7 cases (13%).
The operation time average was about 33.4 minutes (ranged from12–60 minutes) and it was 15 minutes in 29(53.7%) cases , 15 to 30 minutes in18(33.3%) cases and more than 30 minutes in 7(12.9%) cases .
The outcome of procedures in male patients were complete clearance in 24 cases (72.7%) and incomplete in 9 cases (27.3%) while in female clearance were complete in 14(66.7%) and incomplete in 7 cases (33.3%).

In relation to the site of stone complete clearance were 21(75%) , 11(64.7%) and 6(66.6%) in distal ,mid and proximal ureter ; while incomplete clearance were 7 (25%), 6 (35.3%) and 3 (33.3%) respectively .(tab. 1) . Complete clearance of stones with size less than 1cm,1-2cm and those with multiple stone were 22(81.4%) ,15(65.2%) and 1(25%) respectively and incomplete in 5(18.6%) , 8(34.8%) and 3(75%) respectively (tab.1)

Table 1: Clearance of stone in relation to site and size.

		Clearance of stone		Total
		complete	incomplete	
Site	distal	21(75%)	7(25%)	28(100%)
	midureter	11(64.7%)	6(35.3%)	17(100%)
	upper	6(66.6%)	3(33.3%)	9(100%)
Size	<1cm	22(81.4%)	5(18.6%)	27(100%)
	1-2cm	15(65.2%)	8(34.8%)	23(100%)
	multiple	1(25%)	3(75%)	4(100%)
Total		38(70.3%)	16(29.7%)	54(100%)

The operative time was considered as < 15 minutes , 15 to 30 minutes and more than 30 minutes , in male patients the time needed was <15 min in 16 cases (48.5%), 15-30 min in 12 cases (36.3%) and >30 min in 5 cases (15.2%) .While in female patients the same time needed in 13 (61.9%) , 6 (28.6%) and 2 (9.5%) cases respectively .
The operative time was related to the site of the stone and those needed < 15 min were 18(64.2% cases with distal) , 8(47% of cases with midurerter) , and 3(33.3% of cases with proximal) ureteric stones ,while those needed 15 -30 min were 9(32.1%)cases, 4(23.5%) cases and 5(55.5%) cases respectively. More than 30 minutes were needed in one(3.5%) case with distal stone , 5(29.5%) cases with midureteric stone and only one(11.1%) case with proximal ureteric stone.(tab 2)
The cases with smaller ureteric stone required shorter operative time so in cases with stone size <1cm less 15 min were enough in 21(77.7%) cases and15-30 min in 6(22.2%) cases ,and in cases with stone size 1-2 cm 15 min were needed-0 in 7(30.4%) cases ,15-30 min in12(52.1%) cases and more than 30 min in 4(17.3%) cases ,while those with multiple stones 15 min were required for stienstraussa stone in one (25%)case and more than 30 min the other 3(75%) cases. (Tab 2)

Table 2: Operative time according to site and size of ureteric stone.

		Operative time			Total
		<15 min	15-30 min	>30 min	
Site	distal	18(64.2%)	9(32.1%)	1(3.5%)	28(100%)
	midureter	8(47%)	4(23.5%)	5(29.5%)	17(100%)
	upper	3(33.3%)	5(55.5%)	1(11.1%)	9(100%)
Size	<1cm	21(77.8%)	6(22.2%)	0(%)	27(100%)
	1-2cm	7(30.4%)	12(52.1%)	4(17.3%)	23(100%)
	multiple	1(25%)	0(%)	3(75%)	4(100%)
Total		29(53.7%)	18(33.3%)	7(12.9%)	54(100%)

The intraoperative complications were grouped as (proximal migration ,perforation and bleeding). Upward migration were reported in 3 males and 3 females, perforation only in 1 male, and bleeding in 7 males and 3 females.

In relation to the site of stones proximal migration was reported only in one case with distal ureteric stone, 4 cases with mid and only one case with proximal uerteric stone. In only one case perforation occurred in patient with midureteric stone while bleeding were reported in 5 cases with distal stone, 3 cases with midureteric stone and 2 cases with proximal stone.

Intraoperative complications related to the size of stone were upward migration in 4 cases with stone < 1cm and 2 cases with 1-2 cm stones, perforation only in case with stone 1-2cm in size and bleeding in 2 cases with stone < 1cm ,6 cases with stone 1-2 cm and 2 cases with multiple ureteric stones tab. 3

Table 3: Intraoperaoprative complications correlated to the site and size of stone.

		Intraoperative complications			Total
		Upward migration	Perforation	Bleeding	
Site	distal	1(3.7%)	0(%)	5(17.7%)	28(100%)
	midureter	4(23.5%)	1(5.9%)	3(17.6%)	17(100%)
	upper	1(11.1%)	0(%)	2(22.2%)	9(100%)
Size	<1cm	4(14.8%)	0	2(7.4%)	27(100%)
	1-2cm	2(8.7%)	1(4.35%)	6(26%)	23(100%)
	multiple	0	0	2(50%)	4(100%)
Total		6(11.1%)	1(1.9%)	10(18.5%)	54(100%)

Postoperative complications were grouped as infection, urinoma and hematuria . Infections were seen in 6 males and 8 females, urinoma only reported in one male and hematuria were found in 6 males and one female patient.

Postoperative complications with regard to the site of the stone were infection in 7 cases with distal stone, 5 cases with mid ureteric stone and2 cases with proximal ureteric stone . Urinoma occurred in one case with midureteric stone while hematuria were seen in 3 cases with distal stone ,2 cases with midureteric stone and2 cases with proximal ureteric stone tab (4)

Table 4: Postoperative complications related to site and size of stone.

		Postoperative complication			Total
		Infection	Urinoma	Hematuria	
Site	distal	7(25%)	0(%)	3(%)	28(100%)
	midureter	5(29.4%)	1(5.9%)	2(11.76%)	17(100%)
	upper	2(22.2%)	0(%)	2(22.2%)	9(100%)
Size	<1cm	3(11.1%)	0	1(3.7%)	27(100%)
	1-2cm	10(43.5%)	1(4.35%)	5(21.7%)	23(100%)
	multiple	1(25%)	0	1(25%)	4(100%)
Total		14(25.9%)	1(1.9%)	7(12.9%)	54(100%)

Intraoperative complications were higher with longer operative time, for proximal migration they were 2(6.9%) in <15 min, 4(22.2%) in15-30 min; for bleeding 2(6.9%) in <15 min, 3(16.6%) in15-30 min, and 5(71.4%) in >30 min while perforation only occurred once when the operative time prolonged >30 min .table (5)

Table 5: The relation between intraoperative complications and operative time.

		Intraoperative complications			Total
		Upward migration	Perforation	Bleeding	
op. time	<15 min	2(6.9%)	0	2(6.9%)	29(100%)
	15-30 min	4(22.2%)	0	3(16.6%)	18(100%)
	>30 min	0	1(14.3%)	5(71.4%)	7(100%)
Total		6(11.1%)	1(1.9%)	10(18.9%)	54(100%)

Postoperative complications were higher with longer operative times(<15 min, 15-30 min and >30 min) for infection they were 5(17.2%) , 6(33.3%) and3(42.8%) and for hematuria 1(3.5%),4(22.2%) and 2(28.6%) respectively while urinoma complicating perforation occurred in one case when the operative time were mor than 30 minutes . tab(6)

Table 6: Postoperative complications in relation to operative time.

		Postoperative complications			Total
		Infection	Urinoma	Hematuria	
op. time	<15 min	5(17.2%)	0	1(3.5%)	29(100%)
	15-30 min	6(33.3%)	0	4(22.2%)	18(100%)
	>30 min	3(42.8%)	1(14.9%)	2(28.6%)	7(100%)
Total		14(25.9%)	1(1.9%)	7(12.9%)	54(100%)

DISCUSSION:

The optimum choice for the treatment of ureteric stone still unclear ,some advocate the use of medical treatment for small stones while others prefer intervention with either ESWL or intracorpoeal lithotripsy including holmium Yag LASER . However, stone clearance after ESWL can vary and is affected by stone size, chemical composition and location of the stone[17].

In this study most of the patients were males that is similar to other references in which the prevalence of Urolithiasis is higher in males [1,2] . We found that in most cases the ureteric stone were located in the distal ureter (70%) which is similar to that found by other investigators [3] . Flexible and rigid ureteroscopy are used routinely for diagnostic and therapeutic

purposes, and ureteroscopy offers rather wide therapeutic opportunities which yield quite high success rates. The success rate of ureteroscopy in distal ureteral stones has been reported to range from 94 to 99% [18,19].

Our overall success rate of 70.3% for all locations,(66.6% of upper ,64.7% of middle ureteral stones and 75% of lower ureteral stones) seem to be different from that reported by other literature [28,29] this can be explained as follow : in our study those cases (29.7%) that ended with incomplete fragmentation were including cases with upward migration , bleeding that impaired good visualization and perforation that necessitate termination of procedure and placement of DJ stent , other investigators like Y. Ilker did not include these factors in the causes of incomplete fragmentation so they reported higher successful rates reaching up to 95%.[27]

A recent study also showed that stone size does not appear to impact treatment outcome in patients who undergo ureteroscopic lithotripsy [26] and the efficacy of rigid ureteroscopy in stone treatment increases gradually from proximal to distal ureteral localizations. In contrary this study showed that complete fragmentation and clearance rate was higher in smaller stones and in more distal stones

The safety of ureteroscopic interventions has been discussed 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[20,12,22]. In various studies ureteral perforation has been observed in 4–9%[20,23,24]of the cases and in most of these patients the preferred and adequate treatment had been ureteral stent drainage ,and in our study this complication was reported in 1.9% and this seems to be the benefit of our trial to minimize the time of procedures leading to minimal manipulation time as much as possible so we got less incidence of such complication.

Although some authors do not considered stone migration as a complication because of the subsequent possibility of treating these stones with ESWL and reported retrograde stone migration was (1.9%)[25], but we did, because we found that proximal migration of the stones or their fragments is considerable (11.1%) as we practice the fragmentation and forceps retrieval of stones rather than the trend of complete vaporization to minimize the time of procedure and subsequent complications.

However failure of rigid ureteroscopy due to stone migration is still found in 5–18% of the cases[22]. In our material, we exclude those cases from study as we concentrate on the efficacy of fragmentation per se and not to the all procedure.

For intraoperative complications proximal migration was more evident in cases with midureteric stone ,while perforation and bleeding not so differ in relation to site of stone in other hand proximal migrations were more common when stones lesser than 1 cm and bleeding were more when the stone size were bigger.

All postoperative complications (infection, urinoma and hematuria) were higher when operative time was more than 30 minutes that could be attributed to the excessive manipulation that resulted in more tissue damage.

Intraoperative time were within the accepted ranges (the fragmentation needs less time than complete vaporization) compared with others time [27,28,29] .

When all these data are evaluated together, it seems that ureteroscopy and ESWL have similar efficacies in the treatment of ureteral stones.[10,11,12,13] But the trend of stone fragmentation with forceps retrieval rather than complete vaporization of stones required shorter time and less serious complications .

For this reason some authors prefer ureterorenoscopy as a primary treatment in middle and distal ureteral stones[25,17]. Our clinical results, especially with respect to complication rates and outcome, supports these arguments and we advocate the trial of fragmentation with stone retrieval rather complete vaporization to shorten the operative time and subsequent complications.

CONCLUSION:

Our clinical results, especially with respect to complication rates and outcome, advocate the trial of fragmentation with stone retrieval rather complete vaporization to shorten the operative time and subsequent complications.

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