DOI: https://doi.org/10.53350/pjmhs22161674

ORIGINAL ARTICLE

Holmium: YAG Laser in the Management of Impacted Ureteral Stones HYLe Study

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ABSTRACT

Background: Holmium: yttrium-aluminium-garnet (YAG) laser is considered cost-effective and efficient choice in ureteroscopic lithotripsy on all types of stones. We aim to evaluate the efficacy of Holmium: YAG laser in impacted ureteral stones.

Methods: We conducted a prospective case series at the Sindh Institute of Urology and Transplantation (SIUT) Pakistan from 1st October 2016 till 30th September 2017. All adult patients between 18 to 60 years of age with single <20mm ureteral stone impacted for more than one month. The primary outcomes include stone-free and recurrence of ureteric stone during two-year follow-up. Analyses performed using SPSS version 21.0.

Results: A total of 117 patients recruited, of which most were males (61,52.14%). The average duration of disease was 7.82±1.79 months, with a stone size of 12.49±3.8 mm. Most of the stones were located in the middle of the ureter (56,47.86%). Holmium: YAG laser for treatment was effective in 99 (84.62%) cases, and efficacy above 80% in all age groups, but the insignificant difference was observed between both gender, location, duration of disease, size of the stone, use of a guidewire and the different catheter. All of the patients were found to be stone-fragment free at six weeks. The ureteral injury was observed (4,3.41%) and recurrence rate in the same ureter was found in a total of 5 (4.27%) patients.

Conclusions: Holmium: YAG laser lithotripsy may be considered a safe and effective first-line therapy for impacted ureteral stones, avoiding futile repetition and complication of extracorporeal shock wave lithotripsy (ESWL).

Keyword: ureteroscopic lithotripsy, stone-fragment, YAG laser lithotripsy.

INTRODUCTION

Nephrolithiasis, especially ureteric calculus, is a common disease with a painful presentation at the urology clinic with associated health and socioeconomic burden. It has been reported in the literature that its incidence is increasing significantly among the adult population [1, 2]. A stone forming belt that crosses through Southern Asian countries has a prevalence range of 5% - 19.1%, however, the incidence of urolithiasis is considered much higher in Pakistan to 16%, considered to be due to higher temperature and excessive exposure to sunshine [3, 4]. Thailand is another Asian country with higher incidence due to the same reason [5]. Other identified risk factors are renal infection, vitamin A deficiency, prolonged immobilization, hyperparathyroidism, and stricture pathology [6].

The reasons behind a ureteral stone, to get impacted, are larger transverse diameter as compared to ureteral calibre, as well as stone shape, density, and volume, which can lead to hydronephrosis or infection [7]. Due to these reasons, these impacted ureteral stones require urgent intervention to avoid related complications. Current treatment options range from Medical Expulsive Therapy (MET), Extracorporeal Shockwave Lithotripsy (ESWL), uretero-renoscopy and intracorporeal lithotripsy with pneumatic or laser device, and rarely laparoscopic or open surgery [8, 9].

In the recent years, Holmium: YAG (yttrium-aluminium-garnet) laser, in the field of ureteroscopy, has been the laser of choice in ureteroscopic lithotripsy with benefits of being useful on all types of stones and cost-effectiveness. Holmium: YAG laser works on powerful thermal decomposition mechanism which is delivered through small flexible fibres to fragment impacted stone [10, 11]. Recent systematic review summarized it to be an efficient and safer option in almost any patient group and gender, but dependant upon surgeon's skills, technique and operative time [12].

With this background in mind, this study intends to evaluate the efficacy of Holmium: YAG laser in impacted ureteral stones.

MATERIAL AND METHODS

Study design and setting: We conducted this descriptive and prospective case series, to assess the efficacy of Holmium: YAG Laser for treatment of impacted ureteral stones, at the Department of Urology, Sindh Institute of Urology and Transplantation (SIUT) from 1st October 2016 till 30th September 2017. All the recruited patients were followed-up for two years.

Impacted stone was defined as stone in same ureteral position for over one month, with the presence of hydronephrosis and no visualization of contrast medium beyond the stone on intravenous urography. Positive efficacy of Holmium: YAG was defined as no residual stone in the whole length of the ureter evident on X-ray KUB (Kidney-Ureter-Bladder) at six weeks.

All data were collected on computerized pre-structured proforma.

Participants: Inclusion criteria included adult patient of age between 18 to 60 years of age, single diagnosed impacted ureteral stone with size between 5mm to 20mm, and duration of stone for more than one month. Any patient with raised serum creatinine levels, positive urine culture, multiple ureteral stones, and history of coagulopathy.

Variables: Patients were reviewed in the urology stone clinic and, those who met the inclusion criteria were selected by non-probability consecutive technique. Informed consent was taken after explaining about the purpose, procedure, risks and benefits of the study. The Holmium: YAG laser lithotripsy procedure was done in the Surgical Day Care Unit in the lithotomy position. After scrubbing with povidone-iodine solution, cystoscopy was done with 22Fr Cystoscope (STORZ ®). Retrograde pyelography was performed under fluoroscopy; findings were noted and documented. The guidewire was used to negotiate above the stone if possible. A semi-rigid Ureteroscope (Richard Wolf®) size 6/4.8Fr or 8/ 6.4F were used for ureteroscopy. Holmium: YAG laser was used for stone fragmentation. Stone fragments were flushed from the ureter with normal saline irrigation. A temporary ureteric catheter or Double J stent catheter was used when required to avoid obstruction. To avoid bias, the Uretero-renoscopy was done by the consultant urologist. Post-operative X-ray and Ultrasound was done. Patients were discharged on the same day after complete recovery from anaesthesia.

The primary outcomes were whether a patient was a stone-free or developed recurrence of ureteric stone. Secondary outcomes were haematuria, urine infection, urosepsis, stricture, and extravasation of urine.

The final outcome was measured during follow-ups in the sixth week, 6 months, annually by doing ultrasound and x-ray KUB to assess the stone-free status. If there is no residual stone in the whole length of the ureter, the efficacy was labelled as positive.

Study size: The sample size was calculated as 117, with a 95% confidence level and 7% absolute precision.

Statistical methods: Analyses were performed using SPSS version 21.0. Results were described in terms of mean and standard deviation for age, stone size, duration of stone and procedure. The frequency and percentage were calculated for stone-free status and location of stones, use of guide-wire, ureteric catheter, double J stent catheter and efficacy. Stratification was done with respect to age, gender, use of a catheter, use of guide-wire, size of stones and location of stones, duration of stone and procedure to see the effect of these on the outcome. Chi-square test of independence was used to find differences between strata. A p-value ≤0.05 was taken as significant.

Strobe criteria were followed to report this study.

RESULTS

One hundred and seventeen patients with single impacted ureteral stone were included in this study for one year from 1st October 2016, of which 61(52.14%) were males while 56(47.86%) were females. Most of the patients were 41 to 50 years of age (57,48.72) followed by 31 to 40 age group (43, 36.75%) while remaining (17,14.53%) were of age less than 30 years.

Table 1: Demographics of presentation n = 117

Variables	Mean	Median	Standard Deviation
Age (Years)	40.68	40	7.69
Duration of Disease (months)	7.82	8	1.79
Stone Size (mm)	12.49	12	3.58

Table 2: Efficacy of holmium: YAG laser for treatment of impacted ureteral stones with respect to age groups n = 117

Age Groups (Years)	EFFICACY	
	Yes	NO
≤ 30 Years	15(88.2%)	2(11.8%)
31 to 40 Years	32(74.4%)	11(25.6%)
41 to 50 Years	52(91.2%)	5(8.8%)

Table 3: Efficacy with reference to gender, site of stone, duration of disease, size of stone, use of guide wire or catheter

Variables	Efficacy		Total
	Yes	No	
Sex			
Male	50(82%)	11(18%)	61
Female	49(87.5%)	7(12.5%)	56
Site of stone			
Left	63(85.1%)	11(14.9%)	74
Right	36(83.7%)	7(16.3%)	43
Duration of disease			
5 to 7 weeks	44(84.6%)	8(15.4%)	52
8 to 10 weeks	50(86.2%)	8(13.8%)	58
>10 weeks	5(71.4%)	2(28.6%)	7
Size of stone			
6 to 10 mm	41(87.2%)	6(12.8%)	47
11 to 15 mm	37(80.4%)	9(19.6%)	46
16 to 20 mm	21(87.5%)	3(12.5%)	24
Use of guide wire			
Yes	59(81.9%)	13(18.1%)	72
No	40(88.9%)	5(11.1%)	45
Catheter use			
Temporary ureteric	53(88.3%)	7(11.7%)	60
Double J stent	46(80.7%)	11(19.3%)	57

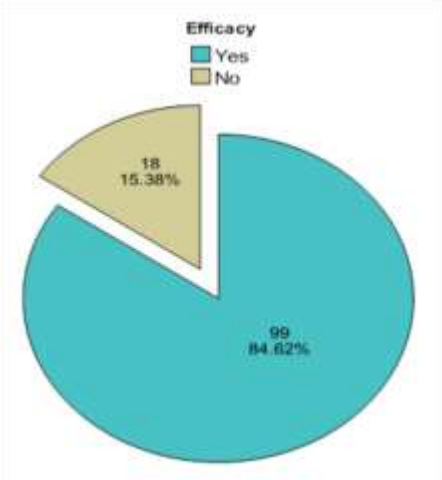

Figure 1: Efficacy of holmium: YAG laser for treatment of impacted ureteral stones n =117

The average age and duration of disease of the patients were 40.68±7.69 years and 7.82±1.79 months, respectively. Most of the times, the stone size was 6mm to

15mm with an average stone size of 12.49±3.8 mm (Table 1). With regards to the location of the stone, most were located in the middle of the ureter (56,47.86%), 32(27.35%) in the upper side whereas 29(24.79%) in the lower side. It was also found that impacted stone most affected left ureter (74,63.25%) while 43 (36.75%) were found in the right ureter.

A guidewire, to negotiate beyond impacted stone, was used in 72/117 (61.54%) cases. Similarly, to avoid post-procedure obstruction, a temporary ureteric catheter was used in 60/117 (51.28%) cases while a double J Stent catheter was used in 57/117 (48.72%) cases.

Figure 1 presents the efficacy of Holmium: YAG laser for the treatment of impacted ureteral stones. It was evident that Holmium: YAG laser for treatment was effective in 99/117 (84.62%) cases. With respect to age groups, efficacy was high in all age groups, but the insignificant difference was observed (p=0.063) as presented in Table 2. Similarly, efficacy was high observed above 80%, but the insignificant difference was observed between male and female patients (p=0.41), in the right and left side stone (p=0.838), among different duration of disease (0.59), different size of the stone (p=0.601), a guidewire (p=0.311) and the different catheter used (p=0.253) (Table 3).

Postoperatively, 8/117 (6.83%) patients complained of fever, haematuria was evident in 5/117 (4.27%), while 10/117 (8.55%) developed urine tract infection (UTI).

All of the patients were found to be stone-fragment free at six weeks with a 100% success rate. During surgery ureteral injury with extravasation of urine was observed in 4/117 (3.41%). This cohort of patients was treated with placement of double J stent for six weeks. Recurrence rate in the same ureter was found in 2(1.71%) patients and in 3(2.56%) patients at first and second-year follow-up respectively. These patients required further management with ureteroscopy with Holmium: YAG laser. During follow-up, stricture formation was evident in 2/117 (1.71%) patients.

DISCUSSION

Sindh Institute of Urology and Transplantation (SIUT) in Karachi, Pakistan is a tertiary care teaching institute which provides health care to about 700,000 patients and conducts over 4000 lithotripsy procedures, annually. Holmium: YAG laser for patient with impacted ureteric stone is accepted treatment and its benefits have been well reported with some inherent risks. This case series focused on the efficacy of the procedure [6, 8, 13-15].

As observed in our study, the male gender is found to a have higher incidence of impacted ureteral stone in different published literature reported to be due to dietary habits [3, 13, 16, 17].

Although the endoscopic procedure and extracorporeal shock wave lithotripsy (ESWL) are the procedures of choice for the treatment of ureteric stones, however, impacted renal stones are more resistant to these therapies, explained by expansion space theory. According to this theory, impacted stones in ureteral mucosa have no natural expansion space, so poor response to ESWL [7, 18]. Retrograde ureteroscopy (URS) is an endoscopic surgery through the urethra orifice and when used with Holmium: YAG laser lithotripsy, has an equivalent or superior result to ESWL for ureteral stones of size less than 4cm, at all levels of ureter [13, 19, 20]. Our result demonstrates that Holmium: YAG laser treatment of impacted ureteral stones can be highly successful. Overall, 84.62 % of our patients were successfully treated with Holmium: YAG laser lithotripsy regardless of size.

This study shows that most stones were found to be impacted in the middle of the ureter, which is comparable with Degirmenci et al [17]. In contrast, literature has shown that mostly stones get impacted in upper ureter [21]. Both of these locations of impacted stones can be explained by anatomical constrictions of the ureter [22]. Our study, like Alazaby et al, also found that impacted stone was most evident in the left ureter [23].

In majority, but not in all patients, we used a guidewire to negotiate beyond an impacted stone. Literature also does not suggest routine use of guidewire except in cases where there is complex anatomy, stone burden or simultaneous use of stone basket [24]. Similarly, to avoid post-procedure obstruction, a temporary ureteric catheter while a double J Stent was used selectively in cases. Likewise, Kucukdurmaz et al and Alazaby et al also did not routinely use double J stent [14, 23].

In our series, an incidence of postoperative complications like fever, haematuria and urine infection was less than 9% with UTI as the most common findings. Literature shows that overall postoperative complication rate ranges from 4% to 13% [17, 23, 25]. As Holmium: YAG laser breaks stones in smaller fragments by the possible thermal effect to pulverize the stone, making it suitable for larger impacted stones. Excellent results are being reported in the literature [13, 15, 20]. All of the patients, in our study, were found to be stone-fragment free at six weeks scan with a 100% success rate. We also observed recurrence stone in the same ureter at first and second-year follow-up, respectively. These patients required further management with ureteroscopy with Holmium: YAG laser. Our results are comparable with Degirmenci et al [17].

Due to the inherent thermal effect, it is no surprise that lateral damage can happen to the wall of the ureter. This injury can be attributed to the fact, describe above, that Holmium: YAG uses a thermal mechanism, the depth of injury has been described to 1mm which can also lead to stricture formation [13, 17]. All four patients in our study, in whom the ureteral injury was identified during the procedure, were with the placement of a double J stent for six weeks. Such ureteric injury should be recognised early during the procedure and treated, to avoid extravasation of urine and further sepsis in the patient.

In our case series, patients tolerated Holmium: YAG laser tolerated very well. It was effective in the majority of cases with respect to age, but the insignificant difference was observed (p=0.063). Similarly, there was an insignificant difference between both gender groups, site, duration of disease, different size of the stone, guidewire and the different catheter used. Our results are comparable to research results [23].

Although prospective study with longer follow-up, we did not have a patient population of impacted stone size more than 2cm, limiting us to confirm its success on larger sized stones. We recommend further study by adding

patients with stone size more than 2cm, comparing with other treatment modalities by randomization.

CONCLUSION

Holmium: YAG laser treatment for impacted ureteric stone may be considered an effective and safe first-line therapy. It can avoid vain repetition of ESWL and problems caused by the prolonged passage of stone fragments.

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