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Original Article

Ureteroscopic Holmium Lasertripsy for Treatment of Impacted Ureteral Calculi

A. M. Abdel Latif

Urology Department, Assiut University Hospital, Assiut, Egypt

ABSTRACT

Objective: To evaluate the efficacy and safety of Holmium: YAG laser lithotripsy for the treatment of impacted ureteral stones.

Patients and Methods: From January 2000 to January 2007, 150 patients (105 males and 45 females) with impacted ureteral stones were treated at the Urology Department of the Assiut University Hospital, Assiut, Egypt. Their mean age was 36 years (range 20 to 66 years). The mean duration of stone impaction was 4.6 months. The patients were managed via the retrograde endoscopic approach using small caliber (6.9 F rigid and 7.5 F flexible) ureteroscopes and the Holmium:YAG laser lithotriptor.

Results: Out of 150 ureteral stones, 144 (96%) were completely fragmented with a single endoscopic procedure. Proximal stone migration occurred in two cases, and the stones were treated by extracorporeal shock wave lithotripsy (ESWL). Intra-operative ureteral perforation occurred in 4 cases and was managed by open surgical treatment. Endoscopic observation revealed inflammatory polyps at the site of impaction in 75 patients and a stricture adjacent to the stone in 20 cases.

Conclusion: Holmium: YAG laser lithotripsy may be considered an effective first-line therapy for chronically impacted ureteral stones, which are frequently associated with chronic inflammation, polyps and strictures. It is quite safe and it avoids the futile repetition of ESWL and problems caused by a prolonged passage of stone fragments.

Keywords : Ureteroscopy, holmium laser, impacted ureteral stone

Corresponding Author: Atef Mohamed Abdel Latif M.D., Urology Department, Assiut University Hospital, Assiut 71516, Egypt. Email: m_az_ahmed@yahoo.com

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INTRODUCTION

Extracorporeal shock wave lithotripsy (ESWL) and endoscopic stone removal are the procedures of choice for the treatment of ureteric stones. However, the management of impacted ureteral calculi (defined as stones that remain at the same site in the ureter for more than two months) remains a challenge for urologists[1,2]. Such calculi are frequently associated with obstructive uropathy and deteriorated renal function[3,4]. ESWL has a variable, but low success rate for impacted stones, which are often resistant to ESWL, whereas ureteral pathology at the site of impaction may prevent spontaneous passage of fragments after ESWL[5]. Ureteroscopic stone manipulation is another option, but its effectiveness decreases with increasing stone size[2]. The development of small caliber ureteroscopes and the greater availability of Holmium: YAG laser lithotripsy now allow for a more successful and safer treatment of impacted ureteral calculi[6,7].

In this study we assess the efficacy and safety of retrograde endoscopy using small caliber ureteroscopes and Holmium: YAG laser lithotripsy in patients with impacted ureteral stones.

PATIENTS AND METHODS

This prospective study included 150 patients (105 males and 45 females) with a mean age of 36 years (range 20 to 66 years) treated for impacted ureteric stones at the Urology Department of Assiut University Hospital, Assiut, Egypt, between January 2000 and January 2007. All patients had symptomatic unilateral impacted ureteric stones (remaining at the same site for more than two months) and normal renal function. All stones were radio-opaque and the mean duration of impaction was 4.6 months (range 2.4 – 6.2 months). Table 1 shows the site and mean size of the stones. All patients were subjected to history taking, clinical, laboratory (urine analysis, blood urea, serum creatinine, coagulation parameters) and radiological (KUB film, abominal ultrasonography and IVU) investigations. Patients with urinary tract infection, bilateral impacted ureteric stones and non-functioning kidneys were excluded from the study.

The patients were treated endoscopically using small caliber ureteroscopes and Holmium: YAG laser lithotripsy. The procedure was performed under general endotracheal, spinal or epidural anesthesia with the patient in the lithotomy and slight anti-Trendelenberg position to avoid upward stone migration during manipulation. Semirigid 7.2 F or rigid 6.9 F ureteroscopes were used for impacted lower ureteric stones. A flexible ureterorenoscope 6.9 F was used for impacted middle and upper ureteric stones. The ureteroscope was advanced up to the level of the impacted stone, and the Holmium: YAG laser was discharged with the fiber tip in contact with the stone surface under direct vision. Treatment was started at the lowest available energy setting of 0.5 J, which was gradually increased as necessary until fragmentation was achieved. The energy and pulse rates were usually set between 0.5 and 1 J and 5 to 10 Hz, respectively. Lithotripsy was continued until the stone was fragmented to the size of sand particles (pulverization of the stone). To verify complete stone fragmentation, a revising ureteroscopic inspection and fluoroscopic imaging were done. An internal ureteral stent was left in situ at the end of the procedure and removed after one month.

A KUB film was done on the second post-operative day to detect any residual fragments. Follow-up at 3, 6 and 12 months included KUB film, abdominal ultrasonography and, if necessary, IVU.

RESULTS

In all patients it was impossible to pass a guide wire beyond the stone at the beginning of the procedure. In 144 patients (96%) the ureteric stones were fragmented completely by a single endoscopic procedure. The maneuver failed in 6 cases because of intra-operative ureteral perforation necessitating open surgical treatment in 4 cases, and proximal stone migration into the kidney in the remaining 2 cases, treated by insertion of a double-J stent and ESWL (Table 2).

Intra-ureteral inflammatory polyps at the site of impaction were observed in 75 cases. Ureteric stricture adjacent to the stone with dilatation and tortuosity of the ureter associated with chronic stone impaction was detected in 20 patients. In these patients a small caliber rigid ureteroscope was helpful to access the stone, while a flexible ureteroscope was preferred when the ureter was so tortuous that a rigid instrument was difficult to pass. Endoscopy also revealed a pinhole stricture below the level of the stone in 2 cases, which was incised with Holmium laser before accessing the stone.

Minor post-operative complications included renal pain in 6 cases and high-grade fever in 3 cases, and all were treated conservatively (Table 2).

Table 1 : Site and diameter of impacted ureteric stones treated with ureteroscopic laser lithotripsy

Site of the stone	Number of patients	Mean (range) stone diameter (mm)
Upper third	65	12 (9 - 16)
Middle third	35	10 (8 - 14)
Lower third	50	8 (7 - 12)

Table 2: Complications and their management in 150 patients treated for impacted ureteric calculi

Complications	No. of patients	Treatment
Intra-operative:		
- Ureteric perforation	4	Open surgical treatment
- Proximal stone migration into the kidney	2	Insertion of double-J stent and ESWL
Post-operative:		
Minor complications		
- High-grade fever	3	Conservative treatment
- Renal pain	6	Conservative treatment
Major complications		
- Stricture at the site of stone impaction	2	Ureteroscopic Holmium: YAG laser endoureterotomy and insertion of double-J stent for 3 months

KUB film done on the second post-operative day showed no residual stones in all cases. Follow-up ultrasonography did not reveal any upper tract dilatation except in 2 cases where IVU revealed a stricture at the site of impaction, which was treated endoscopically by Holmium: YAG laser endoureterotomy and insertion of a double-J stent for 3 months (Table 2).

DISCUSSION

Impacted ureteral stones are more resistant to ESWL than stones located in the renal pelvis. This phenomenon has been explained by the expansion space theory, such that impacted stones in the ureteral mucosa have no natural expansion space and so respond poorly to ESWL[8,9]. Previously, endoscopic treatment of impacted ureteral stones was difficult because of problems such as epithelial hypertrophy and edema leading to an increased risk of ureteral injury during manipulation[2]. A variety of disimpaction maneuvers have been reported, including high pressure, injection of lubricant or lidocaine jelly[10], push-back with a catheter or ureteroscope[11] and ureteral dilation by placing an occluding balloon below the stone[12]. Dretler found that laser lithotripsy had a proven role in treating impacted and non-impacted lower ureteral stones, impacted stones at all levels of the ureter, stones for which ESWL failed and in patients without immediate access to ESWL[13].

The development of small caliber rigid and flexible ureteroscopes as well as the greater availability of laser lithotriptors has allowed a more successful and safer endoscopic removal of ureteral stones[7]. Holmium: YAG laser has proved to be effective for fragmenting even hard calcium oxalate monohydrate stones, including those resistant to pulsed dye laser lithotripsy, such as cystine stones. It can also fragment hard uric acid stones that are resistant to electrohydraulic lithotripsy[14].

In our series endoscopic observation revealed that impacted stones were frequently associated with ureteral strictures and polyps (in 20 and 75 patients, respectively). In patients with chronically impacted stones there may be inflammation and edema of the

ureteral wall, and these changes may spread to the surrounding tissues. Histological studies have revealed chronic inflammation, interstitial fibrosis and urothelial hypertrophy at the site of impaction[15]. Ureteral edema and fibrosis may arise from ischemia secondary to chronic pressure or from an immunological reaction to the stone material. Thus, impacted ureteral stones may stimulate inflammation and cause strictures and polyps[16].

Our results demonstrate that ureteroscopic treatment of impacted ureteral stones can be highly successful. Overall, 96% of our patients were successfully treated with Holmium: YAG laser lithotripsy. ESWL was used to treat 2 cases in whom the stones had migrated into the kidney. These results are similar to those reported by Mugiya et al.[17], but differ from those of Chen et al.[2] who reported a success rate of 84%.

The most troublesome situation is the case of ureteral distortion and kinking causing marked hydronephrosis. Although ureteral kinking complicates the approach to the stone, we found that the use of a small-caliber flexible ureteroscope was helpful. When treating an impacted stone, it is vital to visualize the stone. Once the stone was visualized, Holmium: YAG laser fragmentation could be performed easily. The Holmium: YAG laser was also useful for the treatment of associated ureteral strictures.

We encountered 4 cases of ureteral perforation caused by improper contact of discharged laser fiber with the ureteral mucosa during stone fragmentation; in all cases it was repaired by open surgical treatment. Thus, it is imperative that Holmium: YAG laser lithotripsy be performed only as long as the urologist can visualize the laser fiber tip in contact with the stone surface[18,19].

In conclusion, Holmium: YAG laser lithotripsy may be considered an effective first-line therapy for chronically impacted ureteral stones, which are frequently associated with chronic inflammation, polyps and strictures. It is quite safe and it avoids the futile repetition of ESWL and problems caused by a prolonged passage of stone fragments.

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