

ASSIUT EXPERIENCE IN THE APPLICATION OF HOLMIUM LASER IN TREATMENT OF URETERAL CALCULI IN ADULTS

A.M. ABDEL LATEEF, A.E. ABDEL MONIEM, M.I. TAHA, M.A. SHALABY
Department of Urology, Assiut University Hospital, Assiut, Egypt

Objective This study was carried out to evaluate the safety and efficacy of holmium:YAG laser in the treatment of ureteral calculi in adults.

Patients and Methods Between April 1999 and November 2000, one hundred and seven patients presented to the urology department of Assiut university with symptomatic ureteral stone disease in different locations. The patients were divided into three groups according to the stone location which was determined radiologically. Group I included 38 patients with stones located in the upper third of the ureter, Group II included 19 patients with stones located in the middle third of the ureter and Group III included 50 patients with stones located in the lower third of the ureter. Lithotripsy was done in all patients using the Holmium:YAG laser machine. The stone-free status was checked three months after the procedure. Patients with residual stones were scheduled for another session.

Results In Group I, 38 patients with 38 stones underwent 39 procedures for intracorporeal lithotripsy. Eight patients presented with obstructive anuria and elevated blood urea and serum creatinine. Complete stone frag-

mentation was achieved in 37 cases, while in one case the stone migrated to the kidney and was treated by ESWL. In Group II, 19 patients underwent 20 procedures. Re-treatment after three weeks was necessary in one case due to ureteral wall injury and minimal extravasation. Four patients presented with obstructive anuria, while in 6 patients the stones were impacted. Complete fragmentation could be achieved in all cases. In Group III, 50 patients underwent 51 procedures. A re-treatment session was required in one patient after three months due to a residual stone (5 mm) detected during follow up. In eleven cases the stones were impacted, and one patient had bilateral lower ureteral stones treated in the same session. Out of 50 patients with 55 stones, 54 stones (98.1%) were completely fragmented and cleared in a single session.

Conclusion Holmium:YAG laser lithotripsy is a safe and effective modality for the treatment of ureteral stones.

Key Words Holmium:YAG laser, ureter, lithotripsy

INTRODUCTION

The ongoing development of endourologic technology including the use of the semi-rigid ureteroscope and laser lithotripsy has greatly enhanced the success rate of ureteroscopic lithotripsy¹. Laser energy used for intracorporeal lithotripsy is not a new concept. In 1968 Mulvaney and Beck developed a ruby laser that was able to fragment stones².

The mechanism of holmium laser action with its unique characteristics of longer pulse deviation and wavelength is not related to

photo-acoustic effects but to a photo-thermal mechanism that occurs by direct absorption of the holmium energy by the stone. In other words, the stone is literally melted³. Since its thermal effect can be localized to an area a few millimeters from the fiber tip as long as continuous irrigation is applied, the risk of intraluminal trauma is very low. In short, this laser allows a powerful stone fragmentation in a very safe manner⁴.

Our aim was to evaluate this modality of treatment with regard to safety and efficacy for the management of ureteral calculi in adults.

Table 1: Preoperative Data of the Patients

	No. of Patients	Patients' Age (years)		Stone Burden (mm)	
		Mean	Range	Mean	Range
Group I	38	35.70	19 – 79	11.80	7 – 20.5
Group II	19	36.65	18 – 62	9.65	7 – 18.5
Group III	50	35.37	21 – 65	12.69	8 – 20

PATIENTS AND METHODS

Between April 1999 and November 2000, 107 patients presented to the urology department of Assiut University Hospital with symptomatic ureteral stone disease in different locations

The patients' charts were reviewed for preoperative data. Special attention was given to stone location, size and impaction. The patients were divided into three groups according to the stone location, which was determined radiologically. Group I included 38 patients with single stones located in the upper third of the ureter, Group II included 19 patients with single stones located in the middle third of the ureter and Group III included 50 patients with stones located in the lower third of the ureter. Multiple stones were encountered in four cases while one case had bilateral single lower ureteral stones. All groups had radio-opaque stones. The preoperative data with regard to age and stone burden (which was measured by dividing the sum of the longitudinal and transverse diameters of the stone by two) are shown in Table 1.

In 8 cases of Group I, the stones were obstructing the only functioning kidney. In two cases the stones were residual after surgery, in one case the stone was formed on a neglected JJ stent and in another case the stone had persisted after ESWL treatment.

In Group III, seven patients were anuric due to obstruction of the only functioning kidney.

All patients were subjected to regional spinal anaesthesia and were treated with the Coherent Holmium:YAG laser machine (Coherent Medical Group, Palo Alto, CA) that

produces a pulsed energy light at 2,100 nm. The energy can be varied from 0.2 J to 2.8 J per pulse with a frequency range from 5 to 30 Hz. The light is delivered through a low-water density fiber that is available in different sizes including 200, 365, 550, and 1.000 μm core diameter. The most commonly employed fiber is the 365 μm which requires a working channel of 2.2 Fr. or greater. The depth of penetration yielded by the Holmium:YAG laser is < 0.5 mm. Accurate visualization and placement of the fiber tip were facilitated by a red helium neon targeting beam.

The calculi were treated with small fiber-optic-based, semi-rigid endoscopes ranging from 7.5 to 8.5 Fr. in size, either straight or angled. Multiple retrieval devices including wire-pronged graspers, baskets (helical and flat wire or Segura designs) and forceps were used. Flexible ureteroscopy was resorted to in upper ureteral calculi.

The stone-free status was radiographically checked 3 months after the different procedures and at regular visits every three months for one year. At the first visit plain X-ray and sonography were done, while at later visits the patients were only subjected to sonography. Those who proved to still have residual stones were scheduled to have another session.

RESULTS

In Group I, 38 patients with 38 stones underwent 39 procedures for intracorporeal lithotripsy, one for re-treatment of a residual stone detected on plain X-ray and abdominal ultrasonography during follow-up evaluation. The most common settings to treat the urinary

calculi were a frequency ranging from 10 to 15 Hz and an energy/pulse ranging from 0.8 to 1.5 J. In one case (2.7%) the stone was partially fragmented and migrated up to the upper calyx with large residual fragments. These were treated with ESWL with a success rate of 97.5%. There was no clinically relevant damage to the ureteral wall produced by laser application. At times small haemorrhagic spots were observed, but they did not produce any sequelae, neither immediately nor at follow up. Minor complications included renal colic in two, haematuria in another two and fever in one patient.

In Group II, 19 patients underwent 20 procedures with re-treatment after three weeks in one case due to ureteral wall injury and minimal extravasation encountered during the first session which was ended by placement of a double-J stent. However, all stones were fragmented with a success rate of 100% after the second session. Four patients had presented with obstructive anuria, while in six cases the stones were impacted (i.e. on pre-operative IVU there was no contrast excretion, and no guide wire could be passed beside the stone). The most common settings to treat the urinary calculi were a frequency ranging from 10 to 15 Hz and an energy/pulse ranging from 0.8 to 1.2 J. Minor complications included renal colic in two and fever in one patient.

In Group III, 50 patients with 55 stones were treated with 51 procedures. Re-treatment was done in one case (2%) in which the stone was fragmented to a satisfactory extent as confirmed by intra-operative video monitoring. However, during follow up a residual small stone of about 5 mm was found at the lower end of the ureter, and follow-up sonography revealed a dilated renal unit. Only one case had bilateral lower ureteral stones treated in the same session. In eleven cases the stones were impacted. The most common settings to treat the urinary calculi were a frequency ranging from 10 to 15 Hz and an energy/pulse ranging from 0.8 to 1.2 J. Out of 55 stones treated in 50 patients, 54 stones were completely fragmented and cleared in a single session with re-treatment in one case and a success rate of 100% after the second session. In this group, no complications were encountered except for minor haematuria in two patients.

Follow-up PUT after three months showed no residual stones in all cases, and ultrasono-

graphy did not reveal any upper tract dilatation in any case. No strictures were detected, however, for a definitive evaluation of the effects of holmium:YAG laser treatment on the upper urinary tract and stricture development some more extensive studies with a longer follow-up will be necessary.

DISCUSSION

Many urological units treat an increasing number of calculi with ESWL, which is still considered the least invasive modality. Provided one can visualize the stone ESWL requires less expertise than other modalities. However, the advantages of endoscopic management of ureteral calculi should not be underestimated. Significant obstruction caused by a stone can be relieved more certainly and more rapidly by endoscopy. The development of smaller ureteroscopes is now making it increasingly possible to treat patients without the necessity of general anaesthesia, and the patients' discomfort is reduced to a minimum. It has been predicted that laser fragmentation will become more widely used with an increasing preference for local anaesthesia⁵. In fact, other modalities are less suitable to be used with small flexible ureteroscopes and, therefore, cause more discomfort.

The results of our study were encouraging with a very high total success rate of 98.1% (97.3% for stones located in the proximal third, 100% for stones in the mid-ureter and 98.1% for lower ureteral stones). The average energy used in the three groups was 2.64 KJ, 2.04 KJ and 2.63 KJ, respectively. The average stone burden in the three groups was 11.8 mm, 9.25 mm and 9.7 mm, respectively.

In a large series on 210 patients with 249 renal and ureteral stones treated with holmium laser lithotripsy, Grasso and Chalik reported a 100% success rate for the treatment of 33 stones located in the proximal third, a 97% success rate for the treatment of 29 stones located in the middle third and a 96% success rate for the treatment of 44 stones located in the distal third of the ureter.⁶

In our series re-treatment was required in two cases (one in Group II after extravasation in the first session and the other one due to a residual stone in Group III). These results are comparable to those of Grasso and Chalik⁶.

Scarpa et al. reported on another large series including 150 cases of ureteral stones (22 in the upper, 47 in the middle and 81 in the lower portion of the ureter) with a success rate of 92.6% during 30 days of follow up⁷.

Also Gould reported his first clinical experience with the Holmium:YAG laser and its use in the treatment of urolithiasis. His study included 127 ureteral stones with a success rate of 97%⁸.

In 1999, Tawfik and Bagley reported their experience in the management of upper urinary tract calculi with ureteroscopic techniques with the Holmium:YAG laser being their most common instrument for lithotripsy (92.6%). They treated 82 ureteral stones (29 in the proximal ureter, 19 in the mid-ureter and 34 in the distal ureter). All the stones were successfully cleared after one endoscopic procedure.⁹

Our results are similar to those of Grasso and Chalik⁶ in both their series and those of Tawfik and Bagley⁹, but they are superior to those of Scarpa et al.⁷. All studies, however, yielded a success rate of more than 85%.

During an 18-month period, a total of 107 patients underwent endoscopic laser surgery for the treatment of ureteral stones at our department. We have shown the holmium laser to be clinically effective and safe as a method of intracorporeal lithotripsy. As demonstrated in our study and that of Tawfik and Bagley⁹, the holmium laser can break all types of stones regardless of their composition. We, therefore,

advocate holmium:YAG laser for lithotripsy, especially in the treatment of impacted stones, in anuric patients and for bilateral ureteral manipulation.

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RESUME

L'Expérience de Assiut dans le Traitement des Lithiases Urétérales de l'Adulte par Holmium:YAG Laser

Objectif : Cette étude a été réalisée pour évaluer l'efficacité et l'inocuité du LASER Holmium:YAG dans le traitement des lithiases urétérales de l'adulte. **Patients and Méthode** Entre Avril 1999 et Novembre 2000, cent-sept patients se sont présentés au département d'Urologie de l'Université d'Assiut pour lithiase urétérale symptomatique de sièges divers. Les patients ont été divisés en trois groupes selon le siège du calcul à la radiologie. Le Groupe A comportait 38 patients avec un calcul du tiers supérieur de l'uretère, le Groupe B, 19 patients avec un calcul de siège au tiers moyen et le Groupe C, 50 patients avec un calcul de siège au tiers inférieur de l'uretère. La lithotritie a été pratiquée chez tous les patients utilisant le Laser Holmium:YAG. Le contrôle de l'élimination complète du calcul a été réalisé 3 mois après la procédure. Les patients qui présentaient une lithiase résiduelle

étaient programmés pour une nouvelle session. **Résultats** Dans le Groupe A, 38 patients avec un nombre total de 38 calculs ont bénéficié de 39 sessions de lithotritie intra-corporelle. Huit patients ont présenté une anurie obstructive avec élévation de l'azotémie et de la créatininémie. Une fragmentation complète a été obtenue dans 37 cas, tandis que dans un cas, le calcul est remonté dans le rein et a été traité par lithotritie extra-corporelle. Dans le Groupe B, 19 patients ont bénéficié d'un nombre total de 20 procédures. La seconde séance a été réalisée après trois semaines à cause d'une blessure de la paroi urétérale avec fuite urinaire minime. Quatre patients ont présenté une anurie obstructive, tandis que le calcul s'est impacté dans 6 cas. Une fragmentation complète a été obtenue dans tous les cas. Dans le groupe C, 50 patients ont bénéficié d'un total de 51 sessions. Une seconde séance a été requise chez un patient trois mois plus tard du fait d'une lithiase résiduelle de 5 mm détectée au cours du suivi. Dans 11 cas le calcul s'est impacté, et un patient a eu des lithiases bilatérales du bas appareil urinaire traitées dans la même séance. Sur les cinquante patients présentant 55 calculs, 54 calculs (98,1%) ont été complètement fragmentés et éliminés en une seule session. **Conclusion** La lithotritie par Laser Holmium:YAG est une modalité sûre et efficace de traitement des lithiases urétérales.

All correspondence to be sent to:

Atef Mohamed Abdel Lateef, M.D.
Urology Department
Assiut University Hospital
Assiut 71516
Egypt

Fax: ++20-88-333327
atef_abdlatef@yahoo.com