HOLMIUM LASER: YAG LITHOTRIPSY IN URETERAL CALCULI MANAGEMENT

[1]Juhadi Sunaryo, [2]Zulfikar, [3]HR Danarto.

[1]Department of Urology, Faculty of Medicine/Universitas Indonesia, Cipto Mangunkusumo General Hospital, Jakarta.
[2]Division of Urology, Kardinah Hospital, Tegal, Central Java.
[3]Division of Urology/Department of Surgery, Faculty of Medicine/Gadjah Mada University, Sardjito General Hospital, Yogyakarta.

ABSTRACT

Objective: *To know predictive factors for success of holmium laser: YAG lithotripsy in ureteral calculi management.* ***Materials & Methods:*** *This prospective cohort study was conducted in January 2013 to May 2015 at Kardinah Tegal Hospital Central Java. Patients diagnosed with proximal and distal stones were included. Pediatric, obesity, pregnancy, ureteral anomaly, and ureteroscopy (URS) cannot reach ureteral level of stone were excluded. We used semirigid URS (Wolf) 6/7.5F, monitor video, and holmium laser: YAG litotriptor (Versa Pulse, Lumenis, Germany), with wavelength 2100 nm, output 1-60 watt, fiber length 365 µm, laser power 2.5-10 watt with energy 0.5-1 Joule/5-15 Hz.* ***Results:*** *Of 50 ureteral stone patients, consisted proximal 13 (26%) and distal 37 (74%) were included in this study. Mean age 42.94 ± 11.31 years, with 28 male (56%) and 22 female (44%). Mean stone burden was 88.10 ± 57.41 mm2. There were 6 (12%) patients with multiple stones. This procedure consumed energy 1079.02 ± 1624.00 joule and duration of operation was 19.02 ± 21.17 minutes. We inserted DJ stent after the procedure in 41 patients (82%). There were 2 failure (4%), which were stone migration to kidney and conversion to open surgery. There were significant differences of stone burden (p 0.013), duration of operation (p 0.038), and stone number (p 0.000) with stone free rate, but not in age, sex, stone location and energy. Stone free rate of this procedure was 90%.* ***Conclusion:*** *Stone burden, duration of operation, and stone number were predictive factors for success of holmium laser: YAG lithotripsy in ureteral calculi management.*

Keywords: *Ureteral calculi, ureteroscopy, holmium laser: YAG, stone free rate.*

ABSTRAK

Tujuan: *Mengetahui faktor yang mempengaruhi keberhasilan litotripsi laser holmium: YAG pada batu ureter.* ***Bahan & Cara:*** *Penelitian ko-hort prospektif ini dilakukan pada Januari 2013 sampai Mei 2015 di RSUD Kardinah Tegal, Jawa Tengah. Pasien dengan batu ureter proksimal dan distal dimasukkan sebagai subyek penelitian. Pasien pediatrik, obesitas, hamil, memiliki kelainan anatomi ureter, dan sheath ureteroskopi (URS) tidak dapat mencapai level batu dieksklusi. Tindakan ureteroskopi dilakukan dengan URS semirigid (Wolf) ukuran 6/7.5F, video monitor, dan litotriptor laser Holmium: YAG (Versa Pulse, Lumeynis, Jerman) panjang gelombang 2100 nm, output 1-60 watt, dan serat fiber 365 µm. Kekuatan laser antara 2.5-10 watt dengan energi berkisar 0.5-1 Joule pada 5-15 Hz.* ***Hasil:*** *Sebanyak 50 pasien batu ureter yang terdiri dari ureter proksimal 13 (26%) dan distal 37 pasien (74%) diikutsertakan dalam penelitian ini. Rerata usia pasien 42.94 ± 11.31 tahun, dengan jumlah laki-laki 28 pasien (56%) dan perempuan 22 pasien (44%). Batu ureter multiple didapatkan pada 6 pasien (12%). Rerata stone burden 88.10 ± 57.41 mm2. Pada tindakan URS digunakan rerata energi 1079.02 ± 1624.00 Joule dan lama operasi19.02 ± 21.17 menit. Pemasangan DJ stent setelah operasi sebanyak 41 pasien (82%). Kegagalan tindakan didapatkan pada 2 pasien (4%) yaitu migrasi batu ke ginjal dan konversi bedah terbuka. Terdapat perbedaan bermakna antara stone burden (p 0.013), lama operasi (p 0.038), dan jumlah batu (p 0.000) dengan angka bebas batu, sedangkan usia, jenis kelamin, letak batu, dan energi tidak berhubungan dengan angka bebas batu. Tindakan ureteroskopi dengan litotriptor laser holmium: YAG memiliki angka bebas batu 90%.* ***Simpulan:*** *Stone burden, lama operasi, dan jumlah batu merupakan faktor yang mempengaruhi keberhasilan tindakan litotripsi laser holmium: YAG pada batu ureter.*

Kata Kunci: *Batu ureter, ureteroskopi, laser holmium: YAG, angka bebas batu.*

Correspondence: Juhadi Sunaryo, c/o: Department of Urology, Faculty of Medicine/Universitas Indonesia, Cipto Mangunkusumo Hospital. Jl. Diponegoro No.71, Jakarta Pusat, DKI Jakarta 10430, Indonesia. Phone: +62 21 3152892, Fax: +62 21 3145592. Phone 081282813188. Email: juhadi.md@gmail.com.

INTRODUCTION

The management of ureteral calculi has changed dramatically in the past few decades, from open surgery to minimal invasive treatment.[1,2] The use of simple endoscopy began at 1806 and has developed to advanced urologic equipment nowadays. The modern tools have better stone fragmentation, more efficient stone evacuation, higher stone free rate, and lower morbidity than open surgery.[3] Now, ureteroscopy is using smaller caliber and sophisticated lithotriptor like ultrasound, electrohydraulic, Neodymium laser, pulsed dye laser, and the latest one Holmium laser: YAG.[3-5]

The rigid ureteroscopy was found for the first time by Young and McKay at 1929 when developing endourologic instruments to access upper urinary tract. Goodman had demonstrated feasibility and safety use of rigid ureteroscopy at 1977. Ureteroscopy had developed into semirigid, until Marshal introduced flexible one at 1964. Ureteroscopy is performed not only for diagnosis but also therapeutic purposes.[6]

Holmium laser: YAG is a laser that could be used for some medical purposes including in urology aspect. Holmium laser: YAG is combining CO2 laser as cutting and neodymium laser as coagulant, so it very useful in surgery. In endourologic application, holmium laser: YAG can be transmitted through fiber optic and absorbed well in water. Many medical fields such as orthopedic, ophthalmology, otolaryngology, cardiology, and oral surgery also utilized this kind laser.[7]

The application of holmium laser: YAG in urology field are incision of urethra and ureter stricture, ablation of bladder tumor, resection of prostate, and lithotripsy. Holmium laser: YAG for lithotripsy was introduced for the first time at 1995.[7] Many studies have reported safety and efficacy of this laser. Nowadays, holmium laser: YAG has become treatment choice of many Urologist for ureteral calculi management, because its ability in fragmenting stones.

OBJECTIVE

This study was performed in order to know predictive factors for success of holmium laser: YAG lithotripsy in ureteral calculi management.

MATERIAL & METHODS

This prospective cohort study was conducted to evaluate patients diagnosed with ureteral stone, treated using ureteroscopic lithotripsy with holmium laser: YAG at January 2013 to May 2015 at Kardinah Hospital Tegal Central Java. Sample method is total sampling. We performed radiologic imaging Kidney Ureter Bladder (KUB) photo, ultrasonography (USG), intravenous pyelography (IVP), and computed tomography (CT) in order to characterize the stones. Pediatric, obesity, pregnancy, ureteral anomaly, and ureteroscopy which cannot reach ureteral level of stone were excluded of this study.

The operation procedure was done using semirigid ureteroscopy (Wolf) 6/7.5F with monitor video, and holmium laser: YAG litotriptor (Versa Pulse, Lumenis, Germany), with wave length 2100 nm, output 1-60 watt, fiber length 365 μm, laser power 2.5-10 watt, and energy 0.5-1 Joule/5-15 Hz. All of the procedures was performed by Urologist and senior resident in regional anesthesia. Laser fiber was positioned contacted to the stone, facilitated by red helium-neon light, and never contacted to the ureteral mucosa. Radiologic imaging was done to evaluate stone free rate in a month.

Statistical analysis using T-test, Mann Whitney U test and Chi Square test with SPSS 15.0 was calculated to determine factors related to success procedure. We reviewed age, sex, stone location, stone burdens, stone number, duration of operation, and laser energy whether they influenced the stone free rate.

RESULTS

Of 50 ureteral stone patients with mean age 42.94 ± 11.31 years, consisted of 28 (56%) male and 22 (44%) female. Stone location was 13 (26%) at proximal ureter and 37 (74%) at distal one. Mean stone burden was 88.10 ± 57.41 mm^2 (table 1).

On lithotripsy, we exhausted mean total energy 1079 ± 1624.00 Joule and duration operation was 19.02 ± 21.17 minutes. We performed Double J (DJ) stent insertion after procedure in 41 (82%) patients. Failure was found in 2 (4%) cases, which was migration of stone into kidney and open surgery conversion. The stone free rate of ureteroscopic lithotripsy using holmium laser: YAG was 90%.

We analyzed clinical characteristics of these patients related to stone free status after holmium laser: YAG lithotripsy. We found significant differences of stone burden (p 0.013), duration of operation (p 0.038), and stone number with stone free rate. In this study, there was no significant relationship of age, sex, stone location, and total laser energy with stone free rate (table 2).

Table 1. Characteristics of the subject.

Variables	Value
Age (year), x ± SD (median)	42.94 ± 11.31 (39.5)
Sex	
Male	28 (56.0%)
Female	22 (44.0%)
Stone location	
Proximal ureter	13 (26.0%)
Distal ureter	37 (74.0%)
Stone burden (mm^2), x ± SD (median)	88.10 ± 57.41 (79.29)
Number of stones	
Single	44 (88.0%)
Multiple	6 (12.0%)
Duration of operation (minutes), x ± SD (median)	19.02 ± 21.17 (12)
Laser energy (Joule), x ± SD (median)	1079.02 ± 1624.00 (540)
Insertion of DJ stent	41 (82.0%)
Stone free rate	90.00%
Additional treatment	4 (8%)

Table 2. Bivariate analysis between clinical characteristics of the patients related to stone free status.

Variables	Stone free		p
	No	Yes	
Age, X ± SD	43.47 ± 11.46	38.20 ± 9.60	p 0.328*
Sex, n%			
Male	24 (85.7)	4 (14.3)	p 0.254 #
Female	21 (95.5)	1 (4.5)	
Stone location, n%			
Proximal ureter	12 (92.3)	1 (7,7)	p 0.747 #
Distal ureter	33 (89.2)	4 (10,8)	
Stone burden, mm^2	81.48 ± 53.41	147.69 ± 63.74	p 0.013*
Stone number, n%			
Single	43 (97.7)	1 (2.3)	p 0.000 #
Multiple	2 (33.3)	4 (66.7)	
Duration of operation	18.16 ± 21.73	26.8 ± 14.51	p 0.038 §
Laser energi, Joule	1081.24 ± 1169.56	1059 .00 ± 870.48	p 0 .438 §

*T-test, #chi square test, §Mann-Whitney U test

DISCUSSION

Nowadays, the application of laser technology for intracorporeal lithotripsy is increasing. The Holmium laser: YAG is the most common laser that used for ureteral calculi management .[8] High success rate, patient's preferences, low morbidity and complication rate, and short hospitalization time have made holmium laser: YAG very important. For this reasons, holmium laser: YAG is become treatment choice for most Urologist.[7-9]

The overall stone free rate of holmium laser: YAG lithotripsy for ureteral calculi management in

this study was 90%. This is similiar to Ilker et al 95.1%,[4] Sofer et al 97%,[9] Khoder et al is 95.8%,[10] and Purpurowicz 90.9%.[11] We found that stone burden, duration of operation, and number of stone were predictive factors related to stone free rate; neither age, sex, stone location, nor laser energy.

In this study, stone burden was important predictive factor for success rate. We found larger stone burden in the case of rest stone. Khoder et al found that larger stone burden and diameter were related to stone free rate in holmium laser: YAG lithotripsy.[10] Otherwise, Leitje et al found different result that stone size did not related to stone free rate.[2] This was because the result was influenced by some factors such as different stone composition, endourologic equipments, and operator's skill.[2,6,12,13]

Duration of operation were also influenced stone free rate. Shorter time was found in the success procedure. This proved that laser holmium: YAG lithotripsy was effective treatment. Biyani et al found mean duration of operation 46 minutes with stone free rate 97.9%.[14] Multiple stones was related to stone free rate. Raza et al reported the need of additional ureteroscopy in the case of multiple stones.[12]

Age and sex were not related to success rate in this study. Leitje et al found similar result that age and sex were not related to stone free rate in laser holmium: YAG lithotripsy for ureteral calculi management.[2]

In this study, we found significant differences of stone location, either proximal or distal with stone free rate. The stone free rate of proximal stones was 92.3% and 89.2% for distal one. Leitje et al reported lower stone free rate in proximal ureter 78.6% and 88.1% for distal one,[2] different from Sofer at al reported higher stone free rate which was 97% in proximal ureter and 98% for distal one.[9]

Total laser energy consumed for laser holmium: YAG lithotripsy were not related to stone free rate. In this study, bigger laser energy was consumed for larger stone, because large stone have minimized risk of tissue injury. Total energy for each composite of stone was also different. Lumerman et al reported 2.74J/mg for struvite, 5.81J/mg for brushite, 4.83 J/mg for uric acid, 5.81J/mg for cystin, and 6.02 J/mg for calcium oxalate monohydrate.[15]

Insertion of Double J (DJ) stent after procedure was conducted in 41 patients (82%). The indication were prolonged duration of lithotripsy, impacted stone, mucosa laceration, and solitary kidney.[16] Yip et al reported insertion of DJ stent after procedure in 83% patients.[8] Sofer et al and Denstedt et al reported that insertion of DJ stent after ureteroscopy did not influence stone free rate. They did not need insertion of DJ stent as routine procedure after lithotripsy holmium laser: YAG.[9,16]

There were 2 patients (4%) failed in operation, migration of stone to kidney and open surgery conversion (ureterolitotomy). The difficulties found in operation were severe hydronephrosis and hydroureter in proximal of the stone, resulted migration of stone to kidney and we cannot reach the stone. Then, we did ESWL for the stone. Open surgery conversion was done in case of large, multiple, and impacted stone which was difficult to be fragmented using laser holmium: YAG lithotripsy. Yip et al reported failed procedure was because of proximal migration of stone and large stone.8 Gupta et al reported proximal migration of stone in 3.3% cases.[13]

In general, this study reported ureteroscopic lithotripsy using holmium laser: YAG have high stone free rate. Because of that, holmium laser: YAG lithotripsy is become treatment choice for Urologist in ureteral calculi management.

CONCLUSION

Stone burden, duration of operation, and stone number were predictive factors for success of holmium laser: YAG lithotripsy in ureteral calculi management.

REFERENCES

1. Erhard M, Salwen J, Baglev DH. Ureteroscopic removal of mid and proximal ureteral calculi. J Urol. 1996; 155: 38-42.
2. Leijte JA, Oddens JR, Lock TM. Holmium laser lithotripsy for ureteral calculi: predictive factors for complications and success. J Endourol. 2008; 22: 257–60.
3. Piere S, Preminger GM. Holmium laser for stone management. World J Urol. 2007; 25: 235-9.
4. Ilker Y, Ozgur A, Yazici C. Treatment of ureteral stones using holmium: YAG laser. Int Urol Nephrol. 2005; 37: 31-4.
5. Jeon SS, Hyun JH, Lee KS. A comparison of holmium: YAG laser with lithoclast lithotripsy in ureteral calculi fragmentation. Int J Urol. 2005; 12: 544-7.
6. Gould DL. Holmium: YAG laser and its use in the treatment of urolithiasis: our first 160 cases. J Endourol. 1998; 12(1): 23-6.
7. Wollin TA, Densteds JD. The holmium laser in

Urology. Laser Surg Med. 1998; 16(1): 13-20.
8. Yip KH, Lee CWF, Tam PC. Holmium laser lithotripsy for ureteral calculi: an outpatient procedure. J Endourol. 1998; 12(3): 241-6.
9. Sofer M, Watterson JD, Wollin TA, Nott L, Razvi H, Denstedt JD. Holmium: Yag laser lithotripsy for upper urinary tract calculi in 598 patients. J Urol. 2002; 167: 31–34.
10. Khoder, WY, Brader M, Sroka R, Stief C, Waidelich R. Efficacy and safety of Ho: YAG laser lithotripsy for ureteroscopic removal of proximal and distal ureteral calculi. BMC Urol. 2014; 14(62): 1-7.
11. Purpurowicz Z, Sosnowski M. Endoscopic holmium laser treatment for ureteroltihiasis. J Urol. 2012; 65 (1): 24-7.
12. Raza A, Smith G, Moussa S, Tolley D. Ureteroscopy in the management of pediatric urinary tract calculi. J Urol. 2005; 19(2): 151-8.
13. Gupta PK. Is the holmium: Yag laser the best intracorporeal lithotripter for the ureter? A 3-year Retrospective Study. J Endourol. 2007; 21: 305–9.
14. Biyani CS, Cornford PA, Powell CS. Ureteroscopic holmium lasertripsy for ureteric stones. Scand J Urol Nephrol. 1998; 32: 92-3.
15. Cheung MC, Lee F, Yip SK, Tam PC. Outpatient holmium laser lithotripsy using semirigid ureteroscope. Is the treatment outcome affected by stone load? Eur Urol. 2001; 39: 702–8.
16. Denstedt JD, Wollin TA, Sofer M, Nott L, Weir M, RJ DAH. A prospective randomized controlled trial comparing nonstented versus stented ureteroscopic lithotripsy. J Urol. 2001; 165: 1419–22.