ORIGINAL ARTICLE

Efficacy and safety of semirigid ureteroscopy combined with holmium: YAG laser in the treatment of upper urinary tract calculi: Is it a good alternative treatment option of flexible ureteroscopy for developing countries?

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Abstract

Objective: To assess the success rates of endoscopic management of upper ureteral stones using semirigid ureterorenoscopy and holmium: YAG laser lithotripters.

Method: A total of 74 patients with an established diagnosis of upper ureteric stone and scheduled for endoscopic ureteral stone treatment were retrospectively evaluated. Failure was defined as the inability to contact or fragment the stone, migration of the stone into the renal pelvis and difficulty in visualizing the stone for the second time. Success rates and influencing factors as for stone-free state were investigated.

Results: Mean age of our patients was 45.99±15.00 (range: 24-82) years. In 14 of 74 patients procedural failure was observed. Double J stents were implanted in 65 % of the patients and ureteral catheterization was performed on 20% of them. The total success rate was 81.1 %. Major complication rate was 1.1 percent. Factors effecting the success rate as gender, age, body mass index, grade of hydronephrosis and stone size were evaluated and only age was found to be statistically significant.

Conclusion: Despite some potential risks, semirigid ureterorenoscopic stone extraction and holmium: YAG laser lithotripters are still safe and effective treatment alternatives for management of upper ureteral stones.

Keywords: Upper ureter, Stone, Semirigid ureterorenoscope, Holmium: YAG laser. (JPMA 65: 1193; 2015)

Introduction

Ureterorenoscopy (URS) is defined as endoscopic visualisation of ureter and renal pelvis for diagnostic and/or therapeutic purposes. Though in 1912 Hugh H. Young entered into the dilated ureter of a patient with a posterior urethral valve using a cystoscope, firstly it was in 1979 that Perez-Castro performed URS using an ureterorenoscope. In 1980s, in line with the development of flexible ureteroscopes with working channels, access into upper urinary system and calyces has been more easily achieved. Therapeutic goal in the management of ureteral stones is to ensure complete stone-free state with minimal morbidity. Nowadays, various treatment alternatives such as extracorporeal shock wave lithotripsy (ESWL), retrograde URS, antegrade percutaneous URS, flexible URS and laparoscopic ureterolithotomy are available. Choice of treatment alternatives is directly related to the stone size, composition, location, patients' demographic characteristics (profession, general health state, body posture and obesity etc.), technical facilities and experience of the surgeon.

In the endoscopic management of ureteral stones URS can be used singly or with various lithotripters, which consist of electrohydraulic, pneumatic (PL), ultrasonic (UL) and laser lithotripters (LLs). However, electrohydraulic lithotripters cause serious bleeding and tissue damage, which restrict their use.[1] Currently in the endoscopic management of ureteral stones more frequently PL, ULs or LLs are used. Working principle of PL is based on the conduction of air pressure to the metal bar at a certain frequency. PL can be best performed using rigid instruments. Its parts are very durable and they can be used many times. It should be considered the main disadvantage that broken stone fragments should be extracted one by one using stone forceps if fragments are sized to probe tip equivalent to 0.8 to 1.0 mm as per the probe size used. It can also push the fragments back into the renal collecting system.

In the United States (US) LLs, piezoelectric energy is conducted by means of a metal probe to the stone. Especially the most important superiorities of these lithotripters are their higher efficacy for impacted stones and minimal damage to the surrounding tissues. Besides, it allows suction and elimination of the debris through the channel of the probe. However, it has a restricted use and continuous irrigation is required to prevent excessive warming of the probe. The effectiveness of UL in the fragmentation of hard stones composed of cystine or calcium oxalate monohydrate is inferior relative to PLs.

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The most important disadvantages of LLs are their higher costs and requirement for continual maintenance. Higher successful fragmentation rates have been achieved with these lithotripters. Mainly three sources of laser have been used. Coumarin Dye Laser Lithotripsy and Alexandrite Laser Lithotripsy do not harm guide-wires, but they are ineffective on hard stones. Holmium: YAG (Ho; YAG) Laser is a rapidly absorbable type of laser at 2100 nm wavelength. It works primarily through a photothermal mechanism. When the tip of the probe touches the stone, it promptly vaporises the stone and fragments it into millimetric particles. Every residual stone fragment is eliminated, and stone extraction after the procedure with stone forceps is not required. The zone of thermal injury associated with laser ablation ranges from 0.5 to 1.0mm.[2] This photothermal mechanism and direct impact of laser energy may cause ureteral injury and easily damage guide-wires if used inadvertently. Its most important advantages are nearly 100% fragmentation and stone-free rates. Since extra time is not spent for post-procedural stone extraction, operative durations are much shorter.[3]

URS is a treatment alternative in cases where shock wave lithotripsy failed in patients with impacted or cystine stones, obese patients, individuals with bleeding diathesis, pregnant women and in centres without ESWL facility.[4,5]

The current study was planned to investigate success rates of endoscopic stone treatment using semi-rigid URS and Ho: YAG laser in the management of upper ureteral stones.

Patients and Method

The retrospective study was conducted at Fatih Sultan Mehmet Training and Research Hospital, Istanbul, Turkey, after approval from the institutional ethics committee, and comprised complete hospital records of patients who had a diagnosis of upper ureteral stone and were scheduled for endoscopic ureteral stone treatment between February 2011 and April 2014, and where 9.8/8 F storz semi-rigid ureteroscope and Ho:YAGLLs had been used. Patients who had previously not been treated with ESWL and those with non-opaque calculi were excluded. Upper urinary stones were described as those between the iliac crest line and ureteropelvic junction. In all cases, ureteral balloon dilatation and one guide-wire were used with URS. Any additional tools (stone-cone etc.) were not used for migration. Patients had been post-operatively evaluated with direct urinary X-ray. Failure was defined as inability to contact or fragment the stone, or migration of the stone into the renal pelvis. Success rates and influential factors as for stone-free state were investigated.

For statistical analysis, Number Cruncher Statistical System (NCSS) 2007and Power Analysis and Sample Size (PASS) 2008 softwares (Utah, USA) were used. Descriptive methods (means, standard deviation, median, frequencies, ratio and range) were used. For the comparison of quantitative data and pair wise intergroup comparisons of variables without normal distribution, Mann Whitney U test was used. For the evaluation of qualitative data, Pearson's chi-square, Fisher's Exact Test, Fisher-Freeman-Halton test and Yates Continuity Correction Test (chi-square test with Yates correction) were employed. Statistical significance was evaluated at $p<0.01$ and $p<0.05$.

Results

Records of 74 patients were analysed. The mean age of the patients was 45.99±15.00 years (range: 24-82 years); 33(44.6%) were below 41 years and 41(55.4%) were over 41 years of age. Of the total, 52(70.3%) were male and 22(29.7%) were female patients. Mean body mass index (BMIs) was 29.07±5.21 kg/m^2 (range:15.9-41.6kg/m^2). BMI of 16(40.5 %) patients was within normal range, while 28(37.8 %) were overweight and 30(40.5 %) were obese. Mean stone diameter was 13.08±6.73mm (range: 5-31mm). Hydronephrosis of grades 1 (n=10; 13.5%), 2 (n=43; 58.1%) and 3 (n=21; 28.4%) were detected. Failed or successful procedures were observed in 14(18.9%) and 60(81.1%) patients (Table-1).

Statistically significant difference was not detected between stone diameter and gender ($p>0.05$). Success rates did not differ significantly with respect to BMI values or grades of hydronephrosis ($p>0.05$) (Table-2).

Table-1: Descriptive characteristics.

		Min-Max	Mean±SD
Age (year)		24-82	45.99±15.00
Body weight(kg)		45-115	82.46±14.42
Height (cm)		155-184	168.64±6.91
BMI (kg/m^2)		15.9-41.6	29.07±5.21
Stone diameter (mm)		5-31	13.08±6.73
		n	**%**
Gender	Male	52	70.3
	Female	22	29.7
Age (years)	≤ 41	33	44.6
	> 41	41	55.4
BMI (kg/m^2)	Normal	16	21.6
	Overweight	28	37.8
	Obese	30	40.5
Grade of the hydronephrosis	Grade 1	10	13.5
	Grade 2	43	58.1
	Grade ? 3	21	28.4
Success/Failure	Failure	14	18.9
	Success	60	81.1

BMI: Body Mass Index.

Table-2: Assessments based on successful or failed procedures.

		Procedural fail (n=14) Mean±SD	Procedural success (n=60) Mean±SD	p
Stone Diameter (mm)		12.00±4.76 (12.0)	13.33±7.12 (12.0)	[a]0.667
			n (%)	n (%)
Gender b0.102	Male		7 (50.0)	45 (75.0)
	Female		7 (50.0)	15 (25.0)
Age (years) b0.036*	> 41 years		4 (28.6)	37 (61.7)
	≤ 40 years		10 (71.4)	23 (38.3)
BMI (kg/m^2) c0.196	Normal		5 (35.7)	11 (18.3)
	Overweight		6 (42.9)	22 (36.7)
	Obese		3 (21.4)	27 (45.0)
Grade of the hydronephrosis d0.102	Grade 1		2 (14.3)	8 (13.3)
	Grade 2		5 (35.7)	38 (63.3)
	Grade ≥ 3		7 (50.0)	14 (23.3)

BMI: Body mass index
SD: Standard deviation
[a]Mann-Whitney U test; [b]Fisher's Exact test; [c]Pearson chi-square testi [d]Fisher-Freeman-Halton Test
*p<0,05.

Double J stents were implanted in 48(65%) patients and ureteral catheterisation was performed in 10(20%) of them whereas the remaining were catheter-free. As a major complication, ureteral avulsion developed in 1(1.35%) patient, which was simultaneously treated with exploration plus primary end-to-end ureteral anastomosis.

Discussion

Male/female (M/F) ratio for urinary system stones has been reported as 1/1-1/3 in developing countries.[6] In our study, we detected a male preponderance (M/F:2.3/1). Currently, in the management of upper ureteral stones URS and ESWL are most frequently applied treatment modalities. A study among urologists revealed preference of URS rather than ESWL in the management of upper ureteral stones (54.2 % and 41.3 %, respectively).[7] In a meta-analysis, URS and ESWL were compared for stone-free rates, and higher stone-free rates were detected for URS. However, shorter hospital stays and lower complication rates were reported for ESWL.[8] American Urology Association/European Association of Urology (AUA/EAU) Ureteral Stone Guidelines Panel has indicated stone-free rate of nearly 81.1% for ESWL and URS in the management of proximal ureteral stones. Complications including predominantly ureteral perforation and then long-term ureteral stenosis have been reported as less than 5 percent.[9]

In proximal ureteral stones smaller than 1cm, ESWL constitutes the first treatment alternative. However, difficulties encountered during visualisation of the stone, presence of impacted and/or calcium oxalate monohydrate and cystine stones, actual health state of the patient lower the success rates of ESWL and lead to preference of URS in such cases.[10] However, recent studies have demonstrated that combined use of ESWL and URS has achieved higher success rates in the management of stones up to 2 cm in diameter.[11]

In approaching the ureteral stones primarily semi-rigid URSs are preferred. However, for the management of proximal ureteral stones, semi-rigid and flexible URSs can be favoured in consideration of patients' characteristics and available facilities. Narrow working channel of the flexible URS that force the manipulation of auxiliary instruments and higher procedural costs can be mentioned among the main restrictions of the flexible URSs. However, in cases where safe use of rigid and semi-rigid ureterorenoscopes is impossible or in the situation of stone migration into intrarenal collecting system, flexible URSs remain the optimal option. In paediatric cases, median success rate of flexible URS for upper ureteral stones has been estimated to be72 percent.[12] A study screened 9681 cases with ureteral stones, including 2656 patients with proximal ureteral stones, and showed that mainly semi-rigid URSs had been used in the management of ureteral stones. Stone-free rates were indicated as 94.2%, 89.4%, 84.5% and 76.6% for distal, midureteral, proximal ureteral and multiple stones, respectively. Failure rates and need for a second intervention were found to be significantly higher for semi-rigid URS when compared with flexible URS. Intraoperative complication rate was reported as 3.8-7.7 percent.[13]

It has been acknowledged that ureteroscopes and lithotripters used in the treatment of ureteral stones are important factors for procedural success. Studies performed have demonstrated higher success rates for LL over PL in the management of upper ureteral stones.[14,15] However, larger-scale studies should be performed with ureteroscopes and LLs.

A study[16] comprised a group of patients who had undergone ho:YAGLL or URS for the management of upper urinary system stones; distal (39.8%), midureteral (18.6%), proximal (32.4%) ureteral, and renal (9.4%). Overall stone-free rates were reported as 100%, 97% and 84% for distal, proximal ureteral and renal stones, respectively. The need for a second intervention and complication rates were estimated as 6% and 4 %, respectively.

Another study[17] in its large group analysed upper urinary

system stones managed by ho:YAGLL and URS. Stone diameters ranged between 4 and 30mm (median: 11mm). A total of 374 ureteral stones were reported and 134(35%) of them consisted of upper ureteral stones. Overall complication rate was 7.1 percent. Procedural complications were pain and problems related to ureteral stents (3.2%), urinary tract symptoms (1.4%), ureteral perforations (1.2%), damage caused by laser and guide-wires (0.3%) and atrophic kidney which developed secondary to ureteral stenosis (0.1%).

A current study conducted on the management of upper ureteral stones in developing countries reported success rate of 80 percent.[18] In our study, success rate of 89.1% was obtained. We think that age was the only factor influential on success rates and this finding was regarded as an incidental data of statistical evaluations.

Major complication rate following stone fragmentation with URS appears to be less than 5% in most of the studies cited above. The most frequently seen major complications were ureteral perforation and avulsion and development of ureteral stenosis in the long term. Most of the complications related to URS can be diagnosed per-operatively and their conservative treatment can be performed. In our study, in only one (1.35%) patient major complication was seen and it was treated with concurrent exploration and end-to-end ureteral anastomosis. As a minor complication, fever and haematuria were observed in a limited number of patients without any statistical significance. Long-term complications of ureteroscopic procedures were not observed during the follow-up period.

Conclusion

If an extremely obstructive upper ureteral stone is not the issue or an opaque stone is present, then ESWL should be considered as the main treatment option. In cases where rigid and semi-rigid ureterorenoscopes cannot be used safely or the stone escapes into the intrarenal collecting system, flexible system should be used. Though semi-rigid URS has been developed for the distal ureteral pathologies, in clinical practice it is used for the diagnosis and treatment of all ureteral abnormalities. In centres that cannot afford flexible URS, in selected cases semi-rigid URS can be used in the management of upper urinary system pathologies with higher success rates.

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