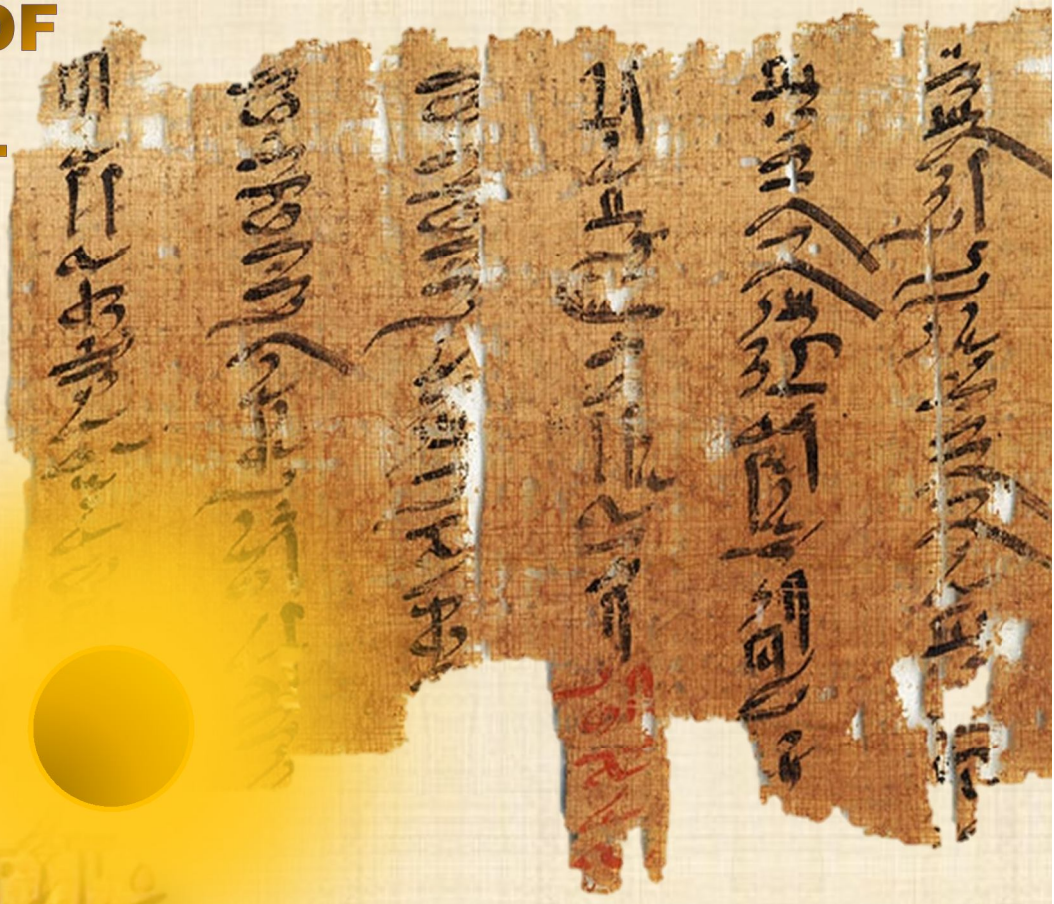
IJMA

International Journal of Medical Arts

VOLUME 2, ISSUE 4, AUTUMN 2020)



http://ijma.journals.ekb.eg/

Print ISSN: 2636 - 4174

Online ISSN: 2682 - 3780

International Journal of Medical Arts 2020; 2 [4]:820-827.

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main subject [Surgery [Urology]] *

Original article

Outcome of Semi-Rigid Ureteroscopy with LASER Lithotripsy for Management of Upper Ureteric Calculi

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Received: July 07, 2020; Revised: August 23, 2020; Accepted: August 23, 2020

DOI: 10.21608/IJMA.2020.21996.1074

ABSTRACT

Background: Proximal ureteral calculi are common with multi-modalities of treatment, with continuous invention of new modalities.

Aim of the work: To present the early experience with LASER lithotripsy using semi-rigid ureteroscopy for treatment of upper ureteral calculi, regarding safety and efficacy.

Patients and Methods: Eighty patients with upper ureteral stones managed by LASER lithotripsy using semi-rigid ureteroscopy were included [30 prospective and 50 retrospective]. Patient evaluation included medical history, clinical examination with preoperative laboratory and radiological investigations. The outcome measure was stone free rate, Intra operative and Postoperative complications, operative time, hospitalization time, and post-operative analgesia.

Results: During the period from January 2018 through February 2020 in 30 prospective cases but retrospectively in 50 cases done in the last two years, 68.8% of patients were males and 31.2% of them were females, mean of age was 43.70 with range from 20 to 66 years, and mean of BMI was 19.75 with range from 18 to 23 with laterality of 60% of patients was right but of 40% was left and stone opacity of 96.25% of patients was radio opaque, while, 3.75% was radio lucent stones the mean operative time was 50.78 minutes and mean duration of hospital stay was 1.3 days. In addition, 66.2% of patient needed JJ, 32.5% required ureteric catheter and 15% failed ESWL. The mean ureteral stone diameter was 10.81. The clearance rate 97.5%; two cases had migrated stone.

Conclusion: Semirigid ureteroscope with LASER lithotripsy is an effective and safe procedure for management of large proximal ureteral stones with a lesser rate of stone migration needs use of flexible ureterorenoscopy.

Keywords: Ureterorenoscopy; Stone; Ureteral; LASER; Semi-rigid.

Please cite this article as: Taha EZM, Rehan MR, Elnady EA, Salih E, Abozeed EA. Outcome of Semi-Rigid Ureteroscopy with LASER Lithotripsy for Management of Upper Ureteric Calculi. IJMA 2020; 2[4]: 820-827. DOI: 10.21608/IJMA.2020.21996.1074

* Main subject and any subcategories have been classified according to research topic.

INTRODUCTION

There are various treatment options for proximal ureteral calculi, including medical treatment [medical expulsive therapy], extra-corporeal shock wave lithotripsy [SWL], ureter-oscopy [URS], percutaneous nephrolithotomy [PNL], laparoscopy and open surgery [1-3].

Ureteroscopes can be categorized by their performance features into three types: rigid, semirigid and flexible types [4-6]. For several decades, semi-rigid ureteroscope was primarily used for the management of mid-ureteral and distal stones, and this technique was associated with high rates of success [7]. With invention of mini ureteroscopes and their associated equipment, semi-rigid ureteroscopy has been applied in certain cases of upper ureteral stones, as a primary treatment or as a salvage therapy for remaining stones after SWL, with a reasonable total success rate [8].

Introduction of holmium laser into the market and worldwide accepted use of LASER during URS makes the rates of stone approval well even for the stones up to 20 mm [9-10].

Our study designed to for evaluate of our early experience with LASER lithotripsy using semi-rigid ureteroscopy for treatment of upper ureteral calculi [The safety and effectiveness]

AIM OF WORK

To present our early experience with LASER lithotripsy using semi-rigid ureteroscopy for treatment of upper ureteral calculi. The safety and effectiveness of the technique was evaluated.

PATIENTS AND METHODS

This is Prospective and retrospective, single arm interventional study was done on eighty patients who had upper ureteral stones, all operations were carried out at Al-Azhar University Hospital [Damietta], Egypt from January 2018 through February 2020 on 30 prospective cases but 50 cases retrospectively in the last two years [only patient with complete medical record and follow-up were included], 55 [68.75%] of cases were males and 25 [31.25%] of them were females, the mean age was 43.71 with ranged from 20 to 66 years; we followed the patient for 3 months.

In this study we present our early experience with LASER lithotripsy using semi-rigid ureteroscopy for management of upper ureteral calculi. The effectiveness and safety of the procedure were evaluated.

The inclusion criteria included: 1] All adult patients aged between 20-60 years old with upper ureteric stone less than 2 cm in diameter, regardless of sex, previous stone management, and 2] Radiolucent stones failed to medical treatment or ESWL. On the other side, exclusion criteria were: Ureteral stricture, active urinary tract infection, pregnancy, skeletal anomalies impeding positioning and huge benign prostatic hyperplasia. The preoperative evaluation included detailed medical history, physical examination and preoperative investigations [Lab assessment, urine analysis, urine culture and sensitivity, plain urinary tract, abdominopelvic ultrasound, Computed tomography urinary tract [CTUT]. In addition, intravenous urography and renal isotope scanning were carried out if indicated].

The study protocol was approved by the local institutional review board [IRB] of Damietta Faculty of Medicine, Al-Azhar University.

On the day of surgery, a prophylactic antibiotic was administered. Patients were placed in the dorsal lithotomy position with the leg of the ipsilateral side of the stone mildly extended and abducted to reduce the pelvic curvature of the ureter to allow easy access to the upper ureter with the URS. Fluoroscopy was positioned with apron protection for the surgeon, nurse and anesthetic doctor. General or spinal anesthesia's were choices of anesthesia of the patients. The tools involved rigid ureteroscopy

[semi-rigid ureteroscopy, Karl Storz, Germany], miniscope, and holmium: YAG laser, fluoroscopy [C-arm fluoroscopy], audiovisual monitor, stone grasping baskets and forceps, and irrigation maneuvers.

Retrograde access to the proximal ureter is usually achieved under endoscopic assistance and imaging. Guide wire was used to safe the procedure. Balloon dilators were also used if necessary. Stone fragmentation was done using a 20W holmium: YAG laser. A 365-500μm laser fiber with an energy output of 1.2-8 J at 8–12 Hz was used. According to the stone hardness and efficacy of lithotripsy the joule and hertz of energy could be altered during the operation. After finishing the procedure, retrograde study was done in some cases to show if there was a residual proximally migrated stone or extravasation, after completing the procedure ureteric stents were fixed when indicated. On the first post-operative day, patients were followed up by KUB for radio-opaque stones and injection of dye in the ureteric catheter for radiolucent stone. Abdominopelvic ultra-sonography, CTUT and IVU were performed if indicated. Follow up period was within three months.

Successful management was measured if the KUB revealed stone free or presence of fragments ≤4 mm [primary end point] Patients who were found to have no residual stones or small fragments ≤4 mm were scheduled for double-J removal if applied [one month].Intra operative and Postoperative complications and causes of the failure of the technique were stated.

At the end of study, records were collected and statistical analysis by suitable statistical tests [Fisher's exact test, Chi-Square test and *t*-test] and analytic programs [SPSS]. Treatment efficacy and safety analyses were performed for the per-protocol [PP] population. A two-sided probability value [*p*-value] of < 0.05 was considered significant.

RESULTS

Our study was on eighty patients who had upper ureteral stones, from January 2018 through February 2020 in 30 Prospective cases but 50 cases retrospectively in the last two years.

In the present work, 55[68.75%] of cases were males and 25 [31.25%] of them were females, the mean age ± SD was 43.71, and the mean BMI ± SD was 19.72. In addition, past medical history was 21 patients [26.25%] and past surgical [urolithiasis] history were 24 patients [30%] [Table 1]

Regarding stone characteristics: 48 [60%] of patients was right, 32[40%] of patients was left, 77 [96.25 %] was radio opaque while, 3.75% was radio lucent stones, the Mean ureteral stone diameter ±SD was 10.813± 3.015, we observed in the our work that the mean ureteral stone diameter <10 mm was 46 cases [57.5%] and >10 mm was 34 cases [42.5%], the Mean ±SD of Hounsfield unit was 903.313±123.219. [Table 2]

Results of the present study revealed that, 62 [77.5%] of patients was mild, 10 [12.5%] was moderate and eight cases [10%] was severe degree of hydronephrosis [Table 2]

In the present work, the time of operation; mean ±SD was 50.775±7.58 min., laser time; mean ±SD was 3.379±0.389 min. double J and ureteric catheter stenting was inserted in 54 cases [67.5%] and 26 cases [32.5%] respectively, fluid irrigation; mean±SD was 6.119±1.205 L [Table 3]

In the present study, the total success rate was in 78 cases [97.5%] and the failure rate was in two cases [2.5%] [Figure 1]. Bivariate analysis of preoperative and intraoperative variables with SFR revealed that significantly lower SFR were found in each of the following situations: [a] large stone burden, [b] when stone cone was not utilized, [c] severe degree of hydronephrosis, and [d] high pressure of fluid irrigation. Hospitalization period ranged from one to three

days, four patients were hospitalized for three days, 16 patients for two days, while 60 patients discharged after one day.

Regard post-operative complications: six patients [7.5%] suffered from post-operative hematuria. Postoperative renal colic, 14 cases [17.5%] suffered from renal colic, 4 cases [5%] suffered from post-operative urinary tract infections, and 20 cases [25%] suffered from post-operative ureteral stent symptoms. A review of data [Table 4], identified that SFR were affected by, large stone diameter, high pressure fluid irrigation and severe degree of hydro-nephrosis which was statistically significant, while the other data were statistically insignificant.

Table [1]: Demographics and comorbidity of studied populations

		Statistics
Sex	Female	25 (31.2%)
	Male	55 (68.8%)
Age		43.70 ± 10.79; 20-66
BMI		19.75 ± 1.10; 18- 23
Comorbidity (past history)	Medical history	21(26.25%)
	Surgical (urolithiasis)history	24 (30%)

Table (2): Stone characteristics and Degree of hydronephrosis

		N	%
Laterality	Right	48	60.00
	Left	32	40.00
Stone opacity	Radio opaque	77	96.25
	Radio lucent	3	3.75
Mean stone diameter	<10 mm	46	57.50
	>10 mm	34	42.50
Mean stone diameter (mm)	Mean ±SD	10.813±3.015	
Hounsfield Unit (H/U)	Mean ±SD	903.313±123.219	
Mild hydronephrosis		62	77.50
Moderate hydronephrosis		10	12.50
Severe hydronephrosis		8	10.00

Table (3): Operative data among studied patients

		N	**%**
Stenting	JJ	54	67.50
	Ureteric catheter	26	32.50
Time of operation (Minutes)	Mean ±SD	50.775±7.581	
Fluid irrigated (Liters)	Mean ±SD	6.119±1.205	
Laser time (Minutes)	Mean ±SD	3.383±0.391	

Table (4): Factors affecting the stone free rate

		Stone free rate				p-value
		Success		Failure		
		N	%	N	%	
Sex	Male	53	67.95	2	100.00	0.470
	Female	25	32.05	0	0.00	
Age	Mean±SD	10.815±43.615		10.607±47.500		0.617
BMI	Mean±SD	1.045±19.745		0.849±19.100		0.391
Past medical history		19	23.75	2	100.00	0.751
Past surgical(urolithiasis) history		22	27.50	2	100.00	
Stone opacity	Radio opaque	75	96.15	2	100.00	0.926
	Radio lucent	3	3.85	0	0.00	
Mean ureteral stone diameter (mm)	Mean± SD	10.641±2.851		17.500±0.707		0.001*
H/U	Mean± SD	904.679±124.505		850.000±0.000		0.539
Mild hydronephrosis		62	79.49	0	0	
Moderate hydronephrosis		10	12.82	0	0	<0.001*
Severe hydronephrosis		6	7.69	2	100.00	
Time of operation (Minutes)	Mean± SD	50.641±7.382		56.000±16.971		0.327
Fluid irrigated (Liters)	Mean± SD	6.038±1.101		9.250±1.061		<0.001*
Laser time (Minutes)	Mean± SD	3.383±0.391		3.200±0.283		0.514

*significant

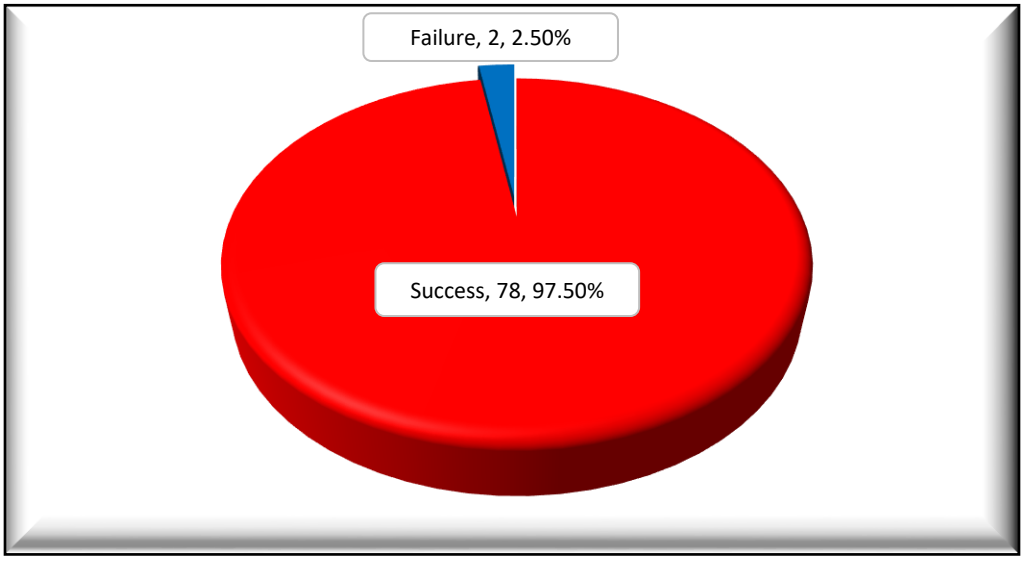

Figure (1): Stone free rate.

DISCUSSION

Regarding the management of urolithiasis, it had been stated that the management upper ureteral large stones are still debated and considered a point of discussion. Ureteroscopic lithotripsy is a minimally invasive procedure for the management of proximal ureteral stones; however, its efficiency decreases in large proximal ureteral stones. Also, in their study found that selection for the management of upper ureteral calculi: stone diameter, strength and period of pain, existence of obstruction and accessibility of tools are factors that define which

management line we select, as reported in previous literature [11-14].

Concerning the stone free rate (SFR) in our study, 78 out of 80 cases (97.5%) were stone free after a single procedure. The failed 2 cases were due to stone migration which dealt with flexible URS.

Regarding to SFR of Preminger et al. who reported that patient considered stone free when all calculi were removed or small sized fragments < 2 mm which detected on X- Ray imaging after completion of the technique. Their stone free rate were considered in 42 (82.4%) patients by a single procedure; The SFR in our study was better than them due to large sized stone and limited visibility in their study [12].

Yencilek et al.[13] reported that SFR was 75.9% were stone free after a single procedure, while the failure rate was 24.1%, the most common cause was stone migration into the kidney, followed by blurred vision due to obvious hematuria, prominent angulation of the proximal ureter and ureteral avulsion caused inability to reach the stone.

Our study was easier concerning the stone free rate in female matched to male patients, although there was no significant difference between the success and failure rate in patients regarding patient demographics and co morbidities [14-15].

We could observe that, large stones and severe degree of hydronephrosis were factors affecting the success rate. No significant relationship has been found between symptoms' severity and the result. In addition, the stone diameter had a significant difference between the success and failure groups which is in agreement with **Mursi et al.**[16] and **Ramello et al.**[17] who reported that, The size and locality of the stones were independent predictors of whole stone removal.

We could notice that there was a significant difference between the success and failure groups regarding to the degree of hydro-nephrosis, which is in agreement with **Hsiao et al.** [18] who reported that the failure rate was increased when large stones and increased degree of hydronephrosis were present.

Fluid irrigation in our study had a significant difference between the success and failure rate which is in accordance with **Prakash et al.**[19] and **Sofer et al.**[20] who reported that irrigation fluid should be warmed pre operatively to avoid hypothermia which may occur to the patient, pressure accuracy of the irrigation fluid is also, important for preventing of stone migration and for avoiding the backward flow of irrigation fluid, bacteria, or endotoxins from the urinary system into the systemic circulation.

Rate of intra operative complication [2.5% of stone migration], is in line with **Yencilek et al.**[13] who reported that stone migration occurred in 16.7%. **Mursi et al.**[16] reported that stone migration occurred in 7% of patients, this may explained by: Forced irrigation, gravitational powers, stone rebound during lithotripsy, failure to reach the calculi or large size stones may make the stone out of reach for the semirigid ureteroscope. **Cui et al.**[21] results were better than our study; they reported no cases of stone migration in there study as they used stone cone to prevent stone migration into the kidney that was used late by us in all cases after recording 2 cases of stone migration.

In our study, Flexible ureterorenoscopy using was restricted to the migrated stones only, which

in turn decreases the incidence of usage of an expensive tool and reduces the total cost of the technique.

Insertion of JJ catheter followed an extended procedure, mucosal damage, impaction, high stone burden, when large fragments where expected. It also saved the obstructed kidneys. It was considered as more safe with less morbidity. It may be the cause of post-operative voiding symptoms which retrieved one month later.

Preminger et al.[12] reported that 87.7% of patients received post-operative stenting, post-operative urinary sepsis and sudden ureteral obstruction were prevented by ureteral stenting which retrieved three months later**.**

Regarding post-operative complications, hematuria was mild and self-limited and noticed more commonly in hepatic patients. Only one case of septicemia was reported from the four cases of UTI, had TLC of 17.000, fever of 39.8, fluids and antibiotics were administered according to urine and blood culture. A low-force of flow of irrigation fluid during our procedure decreases the occurrence of septicemia.

In our study, twenty cases (25%) suffered from irritative symptoms in the form of dysuria, frequency and urgency mainly due to ureteral stent that was applied in 54 cases (66.5%) while ureteric catheter was applied in 26 cases (32.5%) of patients our results were in accordance with **Yencilek et al.[13].** These irritative symptoms were treated with anti-inflammatory and anti-muscarinic drugs**.**

Renal colic was reported in 14 cases (17.5%) with a significant difference between the success and failure groups, they received analgesia and medical expulsive therapy (alpha blockers) which is in accordance with **Cui et al.[21]** and **Yencilek et al.[13],** they reported that renal colic occurred in 12.5% and 20.4%, respectively**.**

In our study, 4 cases (5%) developed UTI noticed more commonly in diabetic patients controlled by antibiotics, which was comparable with the study of **Mursi et al.[16]** in which there were 5 patients (5%) developed UTI controlled by antibiotics**.**

There some limitations were reported in our study. First, this was a single-center study (prospective and retrospective study), and the success rates in altered periods may vary, which may have impacted definite outcomes. Better results may occur in less invasive multi-center adjacent studies performed in a small period together with a distended sample size. In addition, during clinical explanations, we also found that, solidity of the stone and physician skills also affect the success rate. The above factors were not involved in the study due to the limitation of the statistical data. The experimental design will be upgraded and the sample size will be expanded in the future to complete the statistical analysis.

Financial and Non-financial Relationships and Activities of Interest

None.

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International Journal of Medical Arts

https://ijma.journals.ekb.eg/
Print ISSN: 2636-4174
Online ISSN: 2682-3780