Original Article

Outcome of Flexible and Semirigid Ureteroscopy in the Management of Proximal Ureteral Stones Using Laser Lithotripsy

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Abstract:

Background: Proximal ureteric stone often poses therapeutic challenges to urological surgeons. Currently, management of ureteric stone is highly successful with Ho:YAG laser lithotripsy using flexible and semi-rigid ureteroscope. **Objectives:** The objective of the study to evaluate comparative clinical efficacy and safety of flexible and semi-rigid ureteroscopy combined with Ho: YAG laser lithotripsy for treating proximal ureteral stone in real-world settings. **Methods:** This study was conducted as a clinical trial. A total of 82 patients were included in the study through purposive sampling and divided into two comparison groups: Group A (Flexible ureteroscopy with laser lithotripsy) and group B (Semi-rigid ureteroscopy using laser lithotripsy). Follow-up visits were conducted at 1 and 3 months post-operatively to track the stone clearance rate and post-operative complications (hematuria, migration of stone, mucosal disruption, and ureteral stricture). Data analysis was conducted using SPSS version 21, and the chi-square test was used to compare percentages of different outcome variables. A p-value of less than 0.05 was considered statistically significant. **Results:** Among 82 prospective cases, 22 patients were lost to follow-up, leaving 60 patients for final analysis; 75% of patients were males and 25% of them were females, mean of age were 36.21±12.58 and 34.94±10.23 years, respectively ranging from 19 to 65 years, with laterality of 57.1% and 53.1% (Group A and Group B respectively) of patients were right but of 42.9% and 46.9% respectively were left. The mean operative time were 65.0±9.33 minutes and 55.25±11.46 minutes, respectively and mean duration of hospital stay (in both groups) was 51 hours. The mean ureteral stone diameter was 10.57 mm and 10.16 mm respectively. The clearance rate 89.3% and 65.6%. **Conclusion:** Flexible ureteroscopy combined with laser lithotripsy is a highly effective option for treating proximal ureteral stones than semirigid ureteroscopy with laser lithotripsy regarding superior stone-free rates.

Key words: Proximal ureteral stones, Ho: YAG laser lithotripsy, flexible ureteroscopy, semi-rigid ureteroscopy.

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Introduction:

Large proximal ureteral stones frequently cause obstructive uropathy and subsequent deterioration of renal function. So care must be taken to prevent irreversible damage to the kidney[1]. Patients with stone of ≤ 5mm, conservative management may be considered[2]. Whereas chance of spontaneous passage for larger stones and more proximal stones diminishes considerably and thus intervention is required. Proximal ureteral stones can be managed by various techniques including extracorporeal shock wave lithotripsy (ESWL), retrograde ureteroscopy (URS), antegrade percutaneous URS, laparoscopy and open surgery[3]. Choice of treatment depends on the stone size, density, location, radiolucency, anatomical factors, obstruction, technical facilities, patient's preference and experience of the surgeon[4] Extracorpnoreal shock wave lithotripsy (ESWL) and ureteroscopy (URS) have been accepted as the first-line therapy for proximal ureteral stones having low probability of spontaneous passage. ESWL is an effective treatment option for the patients having

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proximal ureteral stones ≤ 10 mm due to noninvasiveness and lower complication rates[5]. However, difficulties encountered during visualization of the stone, presence of impacted stone, 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[6].

Ureteroscopes can be classified by their performance characteristics into rigid, semirigid and flexible types[7]. In recent years, the advent of smaller-caliber ureteroscopes and advances in efficient intracorporeal lithotriptors such as holmium laser has resulted in high success and low morbidity rates[8]. Usage of holmium: YAG laser during URS makes the stone clearance better in a single session even for the proximal ureteral stones upto 20 mm[9]. The holmium: YAG laser has excellent stone fragmenting properties and as a result, it is now a well-established modality for intracorporeal lithotripsy. The most important disadvantage of laser lithotripsy is its higher cost[10]. With the advancements in ureteroscope design and intracorporeal lithotripsy especially holmium laser, most of the ureteral stones can be managed by URS now a days[11]. Proximal ureteral stones can be managed by using flexible or semirigid URS. But flexible URS is a favorable treatment option for proximal ureteral stones with higher stone free rate. On the other hand semirigid URS seems a less successful technique to treat proximal ureteral stones[12].

Methods:

This hospital based prospective study was conducted in the department of Urology, National Institute of Kidney Diseases and Urology, Dhaka from January 2018 to February 2019 to evaluate flexible or semirigid ureteroscopy for management of proximal ureteral stones using laser lithotripsy. A total of 82 patients were selected who fulfill the inclusion criteria. All patients were divided into two groups. Group-A for the flexible ureteroscopy using laser lithotripsy and Group-B for the semirigid ureteroscopy using laser lithotripsy. Age and sex of the patients, side involved of the ureter, size of the stone, time required for lithotripsy, stone clearance, complications and postoperative hospital stay were observed and documented. All patients were followed-up with history, physical examination and investigations like urine RME & C/S, plain X-ray KUB and USG of KUB at 1st & 3rd month after the operation. The results of follow up of each group patient were then compared with other group. But unfortunately 13 patients from group-A and 09 patients from group-B were lost during different follow up period. Finally 60 patients were studied, 28 patients in group-A and 32 patients in group-B. All the data were tabulated in an orderly fashion. The final statistical analysis was performed with the aid of SPSS software version 21.

Results:

In this study out of 60 patients, 28 patients were allocated in group-A and 32 patients were allocated in group-B. The mean±SD age of Group-A and Group-B were 36.21±12.58 and 34.94±10.23 years respectively. The lowest and highest age in both groups was 19 and 65 years. Age categories were almost homogenously distributed in both age groups. Sex distribution between two groups shows that males were predominant in either groups (74.4% in Group-A and 78.1% in Group-B). The groups were almost identical in terms of sex distribution (p=0.550). Involvement of the side of the ureter for the patients is shown in the study. In Group-A 16 (57.1%) right and 12 (42.9%) left ureter and in Group-B 17 (53.1%) right and 15 (46.9%) left ureter were involved. Involvement of the right side were more than left side. The Mean±SD of the stones size (mm) was 10.57±2.04 in Group-A and 10.16±2.45 in Group-B.

Time required for lithotripsy is shown in the study. The Mean±SD of the duration (min) of lithotripsy was 65.0±9.33 min and 55.25±11.46 min in Group-A and Group-B respectively. Operative time was significant between two groups (p=0.001). Stone size had significant positive correlation with operative time in Group A (r=+.775, p<0.001) and Group B (r=+.534, p=0.003) . Stone clearance was more in case of small sized stone in both groups. A complete stone clearance was 89.3% (25) in Group A and 65.6% (21) in Group-B. Mostly observed perioperative complication was haematuria. Postoperative haematuria occurred in 7 (25.0%) and 9 (28.1%) cases in group-A and group-B respectively. Perioperative complications were not statistically significant. The Mean ±SD of duration (hours) of hospital stay was 51.43±10.76 hrs in Group-A and 51.75±10.75 hrs in Group-B. Duration of postoperative hospital stay was not statistically significant (p=0.908). Stone clearance rate after single session was somewhat higher in the group A 25 (89.3%) than that in group B 21 (65.6%) (p=0.031). Almost half of the patients in each group developed UTI after one month of intervention. More than 92% of the patients in group A and 71% in group B exhibited complete clearance of stone (single session) three months after intervention (p=0.036).

Table-I: Age distribution of the patients

Age (years)	Group -A(n=28)		Group -B(n=32)		*p* value
	No	%	No	%	
≤20	2	7.1	1	3.1	
21-30	8	28.6	11	34.4	
31-40	11	39.3	14	43.8	
41-50	3	10.7	2	6.3	
51-60	2	7.1	3	9.4	
>60	2	7.1	1	3.1	
Mean± SD Range	36.21±12.58 19-65		34.94±10.23 19-65		0.665 ns

Table-II: Sex distribution of the patients

Sex	Group-A(n=28)		Group-B(n=32)		*p* value
	No	%	No	%	
Male	20	74.4	25	78.1	0.550ns
Female	8	28.6	7	21.9	
Total	28	100.0	32	100.0	

Table-III: Side involved of the patients

Side involved	Group-A (n=28)		Group-B (n=32)		*p* value
	No	%	No	%	
Right	16	57.1	17	53.1	0.755ns
Left	12	42.9	15	46.9	
Total	28	100.0	32	100.0	

Table-IV: Size of the stones

Stone size(mm)	Group -A (n=28)		Group -B (n=32)		*p* value
	No.	%	No.	%	
≤10 mm	17	60.7	21	65.6	
>10 mm	11	39.3	11	34.4	
Mean±SD Range	10.57±2.04 7.0–15.0		10.16±2.45 7.0–15.0		0.483 ns

Table-V: Duration of operation

Time (minutes)	Group -A (n=28)		Group -B (n=32)		*p* value
	No.	%	No.	%	
40-60	8	28.6	22	68.8	
61-80	19	67.9	10	31.3	
>80	1	3.6	0	0.0	
Total	28	100.0	32	100.0	
Mean±SD	65.0±9.33		55.25±11.46		0.001s
Range	40–85		40–80		

Table-VI: Stone clearance according to size of stone

Group	Stone Size	Stone clearance		*p*-value
		Yes	No	
Group-A (n=28)	≤10 mm	13(92.9%)	1(7.1%)	0.541ns
	>10 mm	12(85.7%)	2(14.3%)	
Group-B (n=32)	≤10 mm	16(66.7%)	8(33.3%)	0.660ns
	>10 mm	6(75.0%)	2(25.0%)	

Table-VII: Stone clearance (Immediate after procedure)

Stone clearance	Group-A(n=28)		Group-B(n=32)		*p* value
	No.	%	No.	%	
Yes	25	89.3	21	65.6	0.031 s
No	3	10.7	11	34.4	
Total	28	100.0	32	100.0	

Table-VIII: Perioperative complications (Immediate)

Complications	Group-A(n=28)		Group-B(n=32)		*p* value
	No.	%	No.	%	
Haematuria	7	25.0	9	28.1	0.784ns
Migration of stone	3	10.7	5	15.6	0.567ns
Fever	3	10.7	3	9.4	0.863ns
Mucosal disruption	1	3.6	2	6.3	0.634ns
None	14	50.0	13	40.6	0.466ns

Table-IX: Duration of postoperative hospital stay

Hospital stay (hours)	Group-A(n=28)		Group-B(n=32)		*p* value
	No.	%	No.	%	
48hrs	25	89.3	28	87.5	
72hrs	2	7.1	3	9.4	
96hrs	1	3.6	1	3.1	
Mean±SD	51.43±10.76		51.75±10.75		0.908ns
Range	48–96		48–96		

Table-X: Comparison of outcome 1 month after intervention

Outcome variable	Group-A(n=28)		Group-B(n=32)		*p* value
	No.	%	No.	%	
Stone clearance	25	89.3	21	65.6	0.031s
UTI	9	32.1	11	34.4	0.855ns

Table-XI: Comparison of outcome three months after intervention

Outcome variable	Group-A (n=28)		Group-B (n=32)		*p* value
	No.	%	No.	%	
Stone clearance	26	92.9	23	71.9	0.036s
Ureteral stricture	0	0.0	0	0.0	

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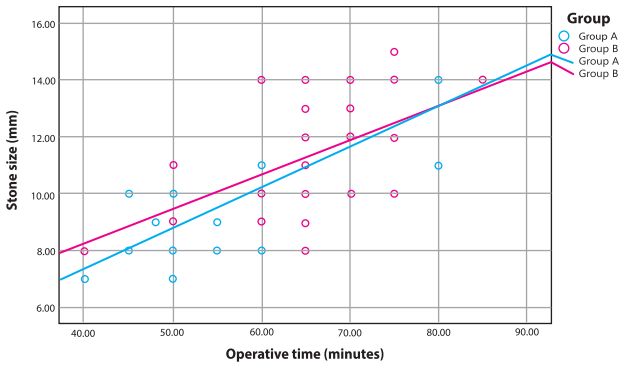

Fig-1: Scatter diagram showing the correlation of stone size with operative time

Group-A: Flexible ureteroscopy using laser lithotripsy
Group-B: Semirigid ureteroscopy using laser lithotripsy

Discussion:

In my study, majority of the upper ureteral stones were found within 40 years. The mean±SD age of Group-A and Group-B were 36.21±12.58 and 34.94±10.23 years respectively. Age categories were almosthomogenously distributed in both age groups and similar to other studies. In case of sex distribution between two groups showed that males were predominant in either groups (74.4% in Group-A and 78.1% in Group-B). The groups were almost identical in terms of sex distribution (p=0.550) and matched the previous studies. In my study, in Group-A 16 (57.1%) right and 12 (42.9%) left ureter and in Group-B 17 (53.1%) right and 15 (46.9%) left ureter were involved. Involvement of the right side were more than left side but not statistically significant. In my study the Mean±SD of the stones size was 10.57±2.04 mm in Group-A and 10.16±2.45 mm in Group-B. Student's T-test (Unpaired) shows no significant difference between two groups (p=0.483). Most of the study's results regarding stone size similar to my study. Abdullateef et al. (2016) reported that stone free rate of flexible ureteroscopy was 88% which was higher than semirigid ureteroscopy that was 79% (p=0.149)[13]. Alkan et al. (2015) reported that stone free after treatment with semirigid ureteroscopy was 76.5% while after treatment with flexible ureteroscopy it was 87.5%. (p=0.078). Galal et al. (2016) reported that stone free status which was achieved at the end of the procedure was 68% in group 1 using semirigid ureteroscopy and 91% in group 2 using flexible ureteroscopy (p=0.02)[14]. Karadag et al. (2014) reported that stone free rate at the end of the procedure was 63.4% in group 1 using semirigid ureteroscopy and 86.8% in group 2 using flexible ureteroscopy (p=0.003). This rate increased to 71.4% in group 1 and 90.1% in group 2 at 1st month radiologic controls (p=0.008). Third month radiologic investigations revealed a stone free rate of 77.7% in group 1 and 93.4% in group 2 (p=0.013). Kotb, Mahmoud and Soliman (2018) reported that the stone-free rate was 90.0% in semirigid ureteroscopy group while it was 93.3% in flexible ureteroscopy group after single session (p=0.640). Yencilek et al. (2009) reported that stone free rate at the end of the procedure was 75.9 % in group using semirigid ureteroscopy and 96.4% in group using flexible ureteroscopy (p=0.001)[15].

In my study, the immediate stone clearance was 89.3% in flexible ureteroscopy group while it was 65.6% in semirigid ureteroscopy group after single session. 92.9% in group-A and 71.9% of the patients in group-B exhibited complete clearance of stone (single session) 3 months after intervention (p=0.036). Stone clearance was more in case of small sized stone in both groups. The result was comparable to the other studies. Abdullateef et al. (2016) reported that the mean operative time in semirigid ureteroscopy group was 29±7 min. while it was 34±11 min in flexible ureteroscopy group (p=0.001). Alkan et al. (2015) indicated that the mean operative time in semirigid ureteroscopy group was 34.1±1.5 min. while it was 49.4±2.3 min in flexible ureteroscopy group (p=0.001). Galal et al. (2016) reported that the mean operative time in rigid ureteroscopy group was 40.9 ± 16.4 min. while it was 48.4±13.8 min in flexible ureteroscopy group (p=0.005). Karadag et al. (2014) found that the mean operative time in semirigid ureteroscopy group was 64.71 ± 16.11 min. while it was 84.06 ± 16.7 min in flexible ureteroscopy group (p=0.001). Kotb, Mahmoud and Soliman (2018) reported that the operative time ranged from 37–88 min with mean value of 55.07 ± 13.24 min in semirigid ureteroscopy group and ranged from 39 – 95 min with mean value of 64.63 ± 17.33 min in flexible ureteroscopy group (p=0.019). Yencilek et al. (2009) reported that the mean operative time in semirigid ureteroscopy group was 33.4±8.9 min. while it was 31.8±6.2 min in flexible ureteroscopy group (p= 0.024) In my study, the operative time ranged from 40 – 85 min with mean value of 65.0±9.33 min in flexible ureteroscopy group and ranged from 40– 80 min with mean value of 55.25±11.46 min in semirigid ureteroscopy group (p=0.001). Stone size had significant positive correlation with operative time in Group A (r=+.775, p<0.001) and Group B (r=+.534, p=0.003). Alkan et al. (2015) indicated that complications which noted in semirigid URS group were in the form of major intraoperative complications

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(ureteral avulsion and ureteral perforation) in 2 (3%) patients, minor ureteral trauma were seen in 6 (9%) patients, intraoperative minor hemorrhage was seen in 1 (1%) patients, postoperative urinary tract infections were observed in 2 (3%) patients, postoperative renal colic were seen in 4 (6%) patients. While in flexible URS group they were in the form of minor ureteral trauma were seen in 3 (5%) patients, intraoperative minor hemorrhage was seen in 4 (6%) patients, postoperative urinary tract infections were observed in 1 (2%) patients, postoperative renal colic were seen in 5 (8%) patients. Galal et al. (2016) reported that complications which noted in rigid URS group were in the form of ureteral perforation was observed in 2 patients (2.8%)), stone migration in 9 (12.5%) patients, postoperative hematuria was observed in 15 (21%) patients, renal colic and fever occurred in 4 (5.5%) patients. While in flexible URS group they were in the form of postoperative hematuria was observed in 11 (17%) patients, renal colic and fever occurred in 3 (4.7%). Karadag et al. (2014) reported that complications which noted in semirigid URS group were in the form of postoper- ative fever was observed in 7 (11.1%) patients, bleeding was noted in 13 (20.6%) patients, ureteral injury occurred in 4 (7.9%) patients. While in F-URS group they were in the form of ureteral perforation below the ureteropelvic junction occurred in 1 (1.6%) patient, postoperative fever was observed in 8 (13.1%) patients, bleeding was noted in 5 (9.8%) patients, ureteral injury occurred in 2 (3.2%) patients.

Kotb, Mahmoud and Soliman (2018) reported that in group A (Semirigid URS) there was 24 cases (80%) free of complications and 6 cases (20%) complicated in the form of failure to access to the stone in 2 cases (6.7%), upward migration of stone toward kidney in 1 case (3.3%), ureteral submucosal passage (minor trauma) in 1 case (3.3%), fever in 1 case (3.3%) and hematuria in 1 case (3.3%). While in group B (Flexible-URS) there was 27 cases (90.0%) free of complications and 3 cases (10.0%) complicated in the form of ureteral submucosal passage (minor trauma) in 1 case (3.3%), fever in 1 case (3.3%) and hematuria in 1 case (3.3%).

Yencilek et al. (2009) reported that complications which noted in semirigid URS group were in the form of gross hematuria was observed in 2 patients (3.7%), stone migration in 9 (16.7%) patients and fever occurred in 1 (1.9%) patient. While in flexible URS group were in the form of gross hematuria was observed in 1 patients (3.6%)), stone migration in 3 (10.7 %) patients and fever occurred in 1 (3.6%) patient.

In my study, in group-A (flexible URS) there was 14 cases (50.0%) free of complications and 14 cases (50.0%) complicated in the form of hematuria in 7 cases (25%), upward migration of stone toward kidney in 3 cases (10.7%), fever in 3 cases (10.7%) and mucosal disruption in 1 case (3.6%). While in group-B (semirigid URS) there was 13 cases (40.6%) free of complications and 19 cases (59.4%) complicated in the form of hematuria in 9 cases (28.1%), upward migration of stone toward kidney in 5 cases (15.6%), fever in 3 cases (9.4%) and mucosal disruption in 2 cases (6.3%). Almost half of the patients in either group developed UTI after one month of intervention but no patient developed ureteral stricture after three months of the procedure. The rate of complications of our study was comparable to other studies.

Upward migration of stones toward kidney that occurred in group-A, were managed by the F-URS as the stone lodge in the pelvis except one case where stone lodged in lower calyx, was managed by DJ stenting. In case of group-B, upward migration of stones were completed by using flexible ureteroscopy with the advantages of deflexion and rotation. In case of mucosal disruptions in both groups were managed by DJ stent placement. Haematuria and fever developed during postoperative period were managed conservatively. UTI in patients were treated by appropriate antibiotic according to urine C/S report. Yencilek et al. (2009) revealed that postoperative hospital stay was 32.0 ± 9.2 hours and 27.0 ± 8.1 hours in the semirigid group and flexible group respectively. Galal et al. (2016) reported that postoperative hospital stay was 18.3 ± 8.3 hours and 18.6 ± 7.8 hours in group 1 (R-URS) and group 2 (F-URS) respectively. In my study, the postoperative hospital stay ranged from 48-96 hours with mean±SD value of 51.43±10.76 hours in flexible ureteroscopy group and 51.75±10.75 hours in semirigid ureteroscopy group. The postoperative hospital stay of our study was higher than other studies.

Conclusion:

Flexible ureteroscopy using laser lithotripsy is a suitable treatment option for proximal ureteral stones with higher stone free rate. Whereas semirigid ureteroscopy using laser lithotripsy is less successful technique and should be used cautiously with availability of flexible URS.

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