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A Propensity Score Matching Analysis for Treating Renal Stones 20-30 mm with Flexible Ureteroscopy and Laser Lithotripsy

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ABSTRACT

Objectives: To assess the outcome of flexible Ureterorenoscopy (F-URS) and LASER lithotripsy as a treatment modality for 2 cm-3 cm renal stone.

Patients and methods: 128 patients underwent F-URS for renal stones were enrolled. 75 Patients had stone burden <20 mm were allocated to group I while 53 patients had stone burden 20 mm-30 mm were allocated to group II. A propensity score matching was implemented to match both groups. After matching, each group included 53 patients. Thereafter, both groups were compared according to Stone Free Rate (SFR), needs for auxiliary procedure and complications.

Results: After matching, the mean operating time in Group II was higher than that in group I p=0.0176. No statistically significant difference in stone free rate between both groups 86.79% VS 75.47% p=0.693. There was a significant difference in need for a second session of RIRS between two groups (P=0.03).

Conclusion: F-URS is a feasible treatment modality for stone 20 mm-30 mm. Need for another procedure and prolonged operative time should be taken into consideration.

Keywords: Renal stones; Flexible ureteroscopy; Laser lithotripsy

INTRODUCTION

The development of a larger endoscope working channel and advancement of deflection mechanism has expanded diagnostic as well as therapeutic indications of flexible ureterorenoscopy. Evolution of Holmium: Yttrium aluminium garnet (YAG) laser and expanding deflection angle facilitate wide utilisation of flexible uretoscope and enable fragmentation of larger and difficulty accessible stones.

The standard treatment option for treating large renal stones ≥ 20 mm or complex renal calculi is percutaneous nephrolithotomy (PCNL) according to European and American guidelines because of its high successful rate [1,2]. However, poor medical condition, obesity and coagulopathies are a challenging situation for percutaneous renal intervention.

The therapeutic gap between the superior overall outcome of PCNL and the minimal invasiveness of F-URS needs to be addressed through refinement of either technique. Many authors documented promising stone free rate of F-URS in treating large renal stone >20 mm with reasonable outcome however, the heterogeneity of studied cohort, due to variation in stone size and density, remains a major limitation [3-5]. In our study, we tried to assess feasibility of F-URS as a treatment modality for large renal stones by matching the studied population.

PATIENTS AND METHODS

We conducted a retrospective cohort-based study for patients underwent flexible uretrorenoscopy and Holmium laser lithotripsy for renal stones. We obtained approval for this study from the local ethical authorities, and each patient signed an informed consent form.

Patients are usually offered PCNL versus RIRS for renal stones 20 mm-30 mm. The possibility of repeated procedures and

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success rate are explained to the patients who agree for RIRS. Patients who have coagulopathy, BMI >30 kg/m2, musculoskeletal deformity and multiple medical comorbidities are primarily offered F-URS.

Study Design

The study included patients who underwent flexible uretrorenoscopy for solitary or multiple renal stones, as determined by a preoperative non-contrast CT scan.

Exclusion criteria were patient age's <18 years old, renal anomalies (horseshoe kidney, pelvic kidney), Ureteropelvic Junction Obstruction (UPJO), concomitant ipsilateral ureteral stone and past history of pyeloplasty or ureteral stricture. Patients are allocated to group I if they have renal stone burden <20 mm while those with a stone 20 mm-30 mm were assigned to group II. Initially, data in both groups were compared and statistically analyzed. A propensity score matching was applied in trying to match the groups to overcome the inherited difference then both groups were compared thereafter.

Surgical Technique

Routine preoperative laboratory investigations are carried out as well as non-contrast CT scans. A negative urine culture was a mandatory before clearance for F-URS. Before induction of anesthesia, 2 gram of 3rd generation cephalosporin is given as a prophylactic antibiotic.

All procedures were performed with the Flex-X flexible ureteroscope. A 11/13 F ureteral access sheath was used for every patient. Lithotripsy was performed using a Holmium laser fiber 200 um. Holmium laser machine was set at 0.5 J-1.5 J energy and firing a rate of 5 Hz-30 Hz according to the technique of lithotripsy used (dusting or fragmentation). Intraoperative clearance of stone fragments was assisted by use of stone basket and pumping system assisted irrigation through ureteral access sheath. In all patients, a Double-J ureteral stent was left in place postoperatively.

Postoperative Management

Patients were often admitted for an overnight stay to monitor vital signs and discharged on postoperative day 1 if no issues occurred such as frank hematuria, persistent loin pain or fever. Hospital stay was calculated from time of hospital admission till discharge time.

Patients were scheduled for clinic visit after 2 weeks with KUB or ultrasound. If no residual fragments amenable for auxiliary procedure were detected, stent removal was decided at the same visit. Patients had sizable residual fragments ≤10 mm were scheduled for shock wave lithotripsy, while those had residuals >10 mm, were prepared for further session of F_URS. After 1 month of the last procedure, follow up low dose CT KUB was performed. Patients were declared stone free if there was no residual stones or the patient had insignificant residuals ≤ 2 mm.

Patients' demographics, stone characteristics [longest diameter, locations within the kidney, Hounsfield Unit (HU)], ASA score, preoperative hydronephrosis and preoperative DJ stent were recorded. Operative time, stone free rate and auxiliary procedures were recorded. The Clavien-Dindo classification was used to evaluate Postoperative complications [6].

Statistical Analysis

SPSS 26.0 for windows was used to gather, tabulate, and analyse all data. The mean, SD, and median (range) of quantitative data were used, while qualitative data were reported as absolute frequencies (number) and relative frequencies (percentage).

To compare two sets of normally distributed data, the independent t-test was employed, whereas the Mann Whitney U test was used for non-normally distributed data. Chi-squared test was used to compare statistical difference of proportions for categorical variables. All of the tests were two-sided. P-values less than 0.05 were deemed statistically significant; p-values greater than 0.05 were considered statistically insignificant Propensity score matching (PSM) is used to reduce the inherent disparity between the two groups of patients. Propensity scores were generated using a logistic regression model that included independent factors such as patient age, body mass index, and Hounsfield unit. To compensate for inherent differences, we used a match tolerance of 0.1 and the nearest neighbour point. After matching, perioperative characteristics, treatment outcome, and recorded complications were compared between the two groups. FUZZY extension 1.0.3 package incorporated into SPSS software was used to calculate PSM.

RESULTS

Our retrospective analysis involved 128 patients diagnosed with renal stones who underwent flexible ureterorenoscopy and laser stone fragmentation. 75 Patients had stones burden <20 mm were allocated to group I while 53 patients had stone burden 20 mm-30 mm were allocated to group II. Initially, a comparison between both groups showed significant statistical difference in patient age, BMI, stone density (Hounsfield unit) and stone size while other studied variables showed insignificant difference (**Table 1**).

Table 1: Before matching patients' demographics and clinical traits

Items	Group I Stone<20 mm (n=75)	Group II Stone 20 mm-30 mm (n=53)	P value
Sex			
Male	46 (61.3%)	28 (52.8%)	b 0.337
Female	29 (38.7%)	25 (47.2%)	
Age (years)			
Median (IQR)	40.28 ± 14.26 37 (10)	33.89 ± 5.44 34 (8)	c 0.007
BMI (kg/m2)	27.71 ± 5.85	30.17 ± 6.69	a 0.029
ASA score			
Median (IQR)	1.89 ± 0.78 2 (2)	1.87 ± 0.78 2 (2)	c 0.853
Stone size (mm)	14.83 ± 2.12	26.30 ± 1.95	a 0.001
Hounsfield unit	733.67 ± 75.87	766.53 ± 47.88	a 0.005
Operation side, n (%)			

Right	31 (41.3%)	19 (35.84%)	b 0.531
Left	44 (58.7%)	34 (64.16%)	
Stone location			
Pelvis	22 (29.4%)	12 (22.6%)	
Upper calyx	25 (33.3%)	19 (35.5%)	b 0.452
Middle calyx	18 (24%)	18 (33.9%)	
Lower calyx	10 (13.3%)	4 (7.6%)	
a=Independent t-Test	b=Chi square test (X2)	c=Mannwhitney test	-

Of the patients in group I, 18 had preoperative stenting, 12 for relieve of obstructive uropathy due to calculus impaction and 6 for inability to access upper urinary system. 9 patients of group II had preoperative stenting due to inability to access upper tract system. Patients from each group were statistically analyzed after propensity score matching. Thereafter, each group included 53 patients (Figure 1). Between the new groups, there were no significant variations in the baseline characteristics of patients or stones (Table 2). Afterwards, all the assessments were made between the new trails.

Table 2: Logistic regression of the significant factors that were included in the matching process

Factors	B	SE	Wald	Df	Significance	OR 95%CI
Age	-0.066	0.029	5.08	1	0.024	0.936
BMI	0.038	0.031	1.53	1	0.215	1.039
Hounsfield unit	0.006	0.003	3.2	1	0.073	1.006

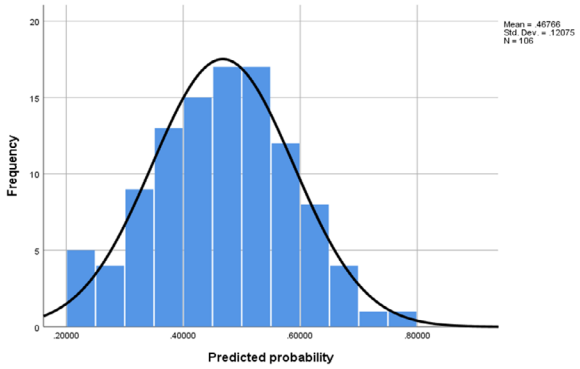

Figure 1: Histogram showing the propensity score matching between the two studied groups

After matching process (Table 3), the mean postoperative hospital stay in both groups was (1.07 ± 0.26 vs 1.13 ± 0.34 days respectively, P=0.08) which is statistically insignificant, while the mean operating times in Group II was higher than that in group I (86.67 ± 18.10 vs 94.52 ± 12.42 min, p=0.0176), which showed statistically significant difference between two groups.

Table 3: Patients' demographics and clinical characteristics after matching

Items	Group I Stone ≤ 20 mm (n=53)	Group II Stone>20 mm (n=53)	P value
Sex n (%)			
Male	25 (47.2%)	28 (52.8%)	b 0.560
Female	28 (52.8%)	25 (47.2%)	
Age (years)	35.51 ± 5.71	33.89 ± 5.44	a 0.138
BMI (kg/m2)	29.62 ± 5.67	30.17 ± 6.69	a 0.619
ASA score	1.94 ± 0.79	1.87 ± 0.785	c 0.623
Median (IQR)	2 (2)	2 (2)	
Hounsfield unit	768.68 ± 46.22	76635 ± 47.88	a 0.814
Hydronephrosis n (%)			
Present	15 (28.3%)	12 (22.65%)	b 0.503
Absent	38 (71.7%)	41 (77.35%)	
Preoperative stent n (%)			
Yes	11 (20.7%)	9 (17%)	b 0.619
No	42 (79.3%)	44 (83%)	
Operation side, n (%)			
Right	22 (41.5%)	19 (35.8%)	b 0.549
Left	31 (58.5%)	34 (64.2%)	
Stone location			
Pelvis	11 (20.7%)	12 (22.6%)	b 0.924
Upper calyx	19 (35.8%)	19 (35.8%)	
Middle calyx	17 (32.1%)	18 (33.9%)	
Lower calyx	6 (11.4%)	4 (7.6%)	
a Independent t-Test	b Chi square test (X2)	c Mannwhitney test	

There was no statistically significant difference in stone free rate between both groups (46 (86.79%) vs 40 (75.47%) p=0.693. 7 patients (13.20%) in group I had documented residual stones, five of them (9.43%) requires second session RIRS and the remaining two patients (3.77%) underwent SWL. In group II, 13 patients (24.53%) had residual stones, a second session of RIRS is required for 10 (18.86%) patients and SWL is required for 3 (5.66%) patients. There was significant difference in need for second session of RIRS between two groups (P=0.03). The stone free rate after second session of F-URS was 96.22% in group I VS 94.33% in group II without significant difference.

According to the Clavien–Dindo classification, no major intraoperative complications were recorded in this study. Eleven (20.75%) patients experienced postoperative hematuria (Clavien I) in group I while, there were only 14 (26.42%) in group II and all were resolved conservatively. According to urine culture tests, postoperative fever necessitating antibiotic medication was seen in four (7.54%) and five (9.43%) patients in groups I and II, respectively (grade II). There was no statistically significant difference in postoperative complications between groups (Table 4).

Table 4: Patients' outcome measures and complications after matching

Items	Group I Stone ≤ 20 mm (n=53)	Group II Stone >20 mm (n=53)	P value
Postoperative hospital stay (days)	1.07 ± 0.26	1.13 ± 0.34	a 0.08
Mean operative time (min)	86.67 ± 18.10	94.52 ± 12.42	a 0.0176
Initial Stone free rate	46 (86.80%)	40 (75.47%)	b 0.693

Clavien-Dindo overall Complications, n (%)	15 (28.30%)	19 (35.85%)	b 0.405
Clavien-Dindo Complications grade, n (%) Grade I	11 (20.75%)	14 (26.42%)	b 0.981
Grade II	4 (7.54%)	5 (9.43%)	
Auxiliary procedures n (%)	7 (13.20%)	13 (24.53%)	b 0.09
Second session RIRS n (%)	5 (9.43%)	10 (18.86%)	b 0.03
SWL n (%)	2 (3.77%)	3 (5.66%)	b 0.72
Final stone free rate post 2nd session RIRS	51 (96.22%)	50 (94.33%)	b 0.92

a Independent t-Test b Chi square test (X2)

DISCUSSION

Urolithiasis is currently one of the most widespread urologic disorders with a rise in prevalence and recurrence [7,8]. Both American and European urological association recommended percutaneous nephrolithotomy as primary treatment modality for renal stones >20 mm. When PCNL is not amenable, large renal calculi >2 cm can be treated with flexible ureterorenoscopy or by shock wave lithotripsy or combination of both, but in these situations repeated session may be needed and long term follow up or DJ stenting may be required for long duration [2,9,10].

The balance between minimal invasiveness of F-URS and the higher success rate of PCNL should be taken in consideration in decision making [2,9]. In special situation as in obesity, coagulopathies or sever skeletal deformities, RIRS should be considered as a first choice for treating renal stones [11]. A group of investigators suggested that the indication of RIRS may be expanded to be the modality of choice for treating larger renal stones in special situations [12].

Many authors reported promising stone free rate following treating large stones with F-URS [3-5]. Hyams et al. reported using RIRS for renal stones treatment with diameters of 20 mm-30 mm in 120 patients [13]. They reported 63% stone free rate, when no residual or clinically insignificant fragments of <2 mm were identified that is less than that of our research (94.33%). It may be attributed to using dusting technique in laser lithotripsy and irrigation pump during the procedure. Giusti et al. reported about 80% stone free rate for 316 patients treated with FURS with stone burden >15 mm after first session which is lower than that in our study post first session (86.8%) [14]. Their results post 2nd and 3rd session is 89.5% and 91.5% respectively but our results post second session were better and there was no need for 3rd session. They conclude that F-URS procedure is safe and effective, and a repeated session is needed to get better SFR for large renal calculi.

Repeated procedures could be accompanied with increased SFR. Prabhakar reported 100% SFR could be reached by single or staged sessions of FURS in their study on renal stones with diameter of 25 mm [12]. Ben Saddik et al. in their study on renal stones 20 mm-30 mm, found that SFR 89.3% post two-session of FURS and 97.1% after three sessions [15]. The higher SFR in our study could be due to combined dusting and extraction technique for laser lithotripsy.

Treating large renal stones with RIRS would definitely be associated with prolonged OR time. In a mean operating duration of 83 minutes, Breda and coworkers recorded 93% success with average stone size of 22 mm [3]. In our study, we have comparable mean OR time 94 min. Mariani et al. reported mean operative time 64 minutes (30 minutes-240 minutes) for F-URS in dealing with 33 mm stones which is lower than to that in our study [16]. The discrepancy in OR time may be explained by the variation of stone burden between different reports.

Post URS urosepsis was reported in 3%-5%, and its risk increased with an increase in stone size [17]. In our study, no patient developed urosepsis which may be due to routine use of ureteric access sheath that enables continuous lower intrarenal pressure. Our study is not devoid of limitations, we tried to overcome the selection bias by matching group before statistical analysis. However, a prospective randomised study on a large scale of patients would be helpful in deciding treatment modality for large renal stone.

CONCLUSION

Flexible uretrorenoscopy and laser stone disintegration is effective and safe treatment option for stone 20 mm-30 mm. Need for another procedure and prolongation of operative time should be taken in consideration and need to be discussed with patients.

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The authors did not receive support from any organization for the submitted work.

CONFLICT OF INTERESTS

All authors declare that they have no conflicting interests

AUTHOR'S CONTRIBUTION

- HM shello: Project development, Data Collection, Manuscript writing
- Salama.: Manuscript writing/editing
- Samaha: Data analysis
- Abdelaziz elhendawy : Data collection
- Shabana.: Manuscript writing

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