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Original article

Stone Dusting and Spontaneous Passage versus Fragmentation and Active Fragment Retrieval Using Flexible Ureteroscopy for Lower Calyceal Stones 1 to 2 cm: Comparative Study

Salah E. El-Bashir, Elsayed A. Ismail, Rabea G. Omar,
Magdy A. EL-Tabey, Kareem A. El-Attar

Abstract:

Background: Flexible ureteroscopy (FURS) is currently the preferred treatment option for most uncomplicated renal calculi. It has been shown to be more effective than shockwave lithotripsy (SWL) for small calculi < 20 mm. We aimed to compare stone dusting and spontaneous passage vs fragmentation and active fragment retrieval using fURS for lower calyceal stones 1 to 2cm. **Methods:** This prospective cross-sectional study was conducted on one-hundred patients with kidney stones who were admitted to our department for retrograde intrarenal surgery (RIRS) aged above 18 years old. The patients were divided into two groups: Group A (N=50): stones were dusted using low energy and high frequency with the tip of the laser fibre was moved over the stone surface and Group B (N=50): stones were fragmented using higher energy and lower frequency and the stone was disintegrated into fragments that were extracted using a nitinol basket. **Results:** Operative time was significantly shorter in group A compared to group B (P value >0.001); FURS were significantly better in group B compared to group A (P value =0.022). Hospital stays, SWL, semi-rigid URS, second flexible and postoperative complications were insignificantly different between the studied groups (P value >0.05). **Conclusions:** FURS for renal stones, the dusting technique had a significantly shorter operation time, whilst the fragmentation technique had a significantly better SFR. Both techniques have comparable safety, hospital stay and requirement for secondary procedures.

Keywords: Stone Dusting; Fragmentation and Active Fragment Retrieval; Flexible Ureteroscopy; Lower Calyceal Stones.

Urology Department, Faculty of Medicine Benha University, Egypt.

Corresponding to:
Dr. Elsayed A. Ismail.
Urology Department, Faculty of Medicine Benha University, Egypt.
Email:
Sayedismail2016@gmail.com

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Introduction

Flexible ureteroscopy (fURS) is currently the preferred treatment option for most uncomplicated renal calculi [1]. This has resulted from the marked improvement in fURS designs, laser lithotripsy machines and techniques, as well as working instruments [2]

It has been shown to be more effective than shockwave lithotripsy (SWL) for small calculi < 20 mm [3].The holmium: yttrium-aluminium-garnet (YAG) laser has become the preferred lithotripter device because of its high efficacy and the availability of small-diameter (200 μm) flexible laser fibers, which can pass through the fURS and reach any site in the calyceal system [4].

Holmium laser lithotripters allow the urologist to control laser settings (energy and frequency) to adjust the power that is delivered at the tip of the laser fibre[5]. Low energy (0.2–0.5 J), high frequency (15–40 Hz) lithotripsy results in tiny fragment sizes that can pass spontaneously, and this technique has been termed 'dusting'. On the other hand, higher energy levels (1–1.2 J) with lower frequencies (6–10 Hz) results in fragments that require active retrieval with baskets and this technique has been termed 'fragmentation' [4].

The widespread use of holmium laser lithotripsy has created debates about the best laser lithotripter settings. A few studies have compared fragmentation and active retrieval with dusting and spontaneous passage for renal stones [6].

For 1–2 cm size lower pole stones, European Association of Urology guidelines recommend either percutaneous nephrolithotripsy (PCNL) or flexible URS in patients with unfavourable factors for shock wave lithotripsy (SWL). In contrast, the American Urological Association (AUA)guidelines recommend flexible URS as first-line therapy for lower pole stones greater than 1cm, whereas PCNL is recommended for stones greater than 2 cm [7]. We aimed to compare stone dusting and spontaneous passage vs fragmentation and active fragment retrieval using flexible ureteroscopy (fURS) for lower calyceal stones 1 to 2cm.

Patients and Methods

This prospective cross-sectional study was conducted on 100 patients with kidney stones who were admitted to the urology department of Benha university hospitals for RIRS aged above 18 years old, of both sexes, and were diagnosed with unilateral lower calyceal stone 1 to 2 centimetres . The patients provided informed written consent before participating in the study. The research was conducted within the approved guidelines of the institutional ethical committee of Benha University Hospitals (Approval code: MS 4-4-2022) from March 2022 to September 2023.

The exclusion criteria were patients with urological infection, patients with multiple stones and patients with congenital urogenital anomalies.

Grouping:

The patients were divided into two groups; Group A: stones were dusted using low energy and high frequency with the tip of the laser fibre was moved over the stone surface , Group B: stones were fragmented using higher energy and lower frequency and the stone was disintegrated into fragments that were extracted using a nitinol basket.

Preoperative assessment:

All patients were subjected to proper and detailed history taking (present history included Patient's first complaint, onset of the disease, duration, and its progression, past history (history of chronic diseases such as hypertension and diabetes mellitus history of previous urological disorders, history of previous medications, history of surgical interventions especially urological) and thorough full physical examination. Laboratory investigations including routine pre-operative investigations and urine analysis.

Imaging Study were assessed in all patients including Plain X-ray (PUT) of the urinary tract, pelviabdominal

ultrasonography and non-contrast enhanced computed tomography(CTUT).
All data were recorded including [age, sex, body mass index (BMI), stone size.
Stone side, stone density and comorbidity].

Intraoperative assessment:

All procedures were performed by using single use digital flexible ureteroscope (LithoVue, Boston Scientific, USA), and 9.5–11.5 Fr ureteral access sheath was used to lower the intra renal pressure, under general anaesthesia and in lithotomy position, a guidewire was placed via cystoscopy under fluoroscopic guidance into the renal pelvis. Then a dual-lumen catheter was used to place a second guidewire. fURS was introduced over the second guidewire or through a ureteric access sheath, The patients were divided into two groups; stones were either dusted or fragmented. Dusting was done using low energy and high frequency (0.3–0.5 J and 15–20 Hz), and the tip of the laser fibre was moved over the stone surface (painting movement). While for fragmentation higher energy and lower frequency (1–1.2 J and 6–10 Hz) were used and the stone was disintegrated into fragments that were extracted using a nitinol basket. Operative time and radiation time exposure were recorded.

Postoperative Follow-up:

PUT was taken after 1 day to confirm proper placement of the ureteric stent. Another PUT was performed after 3–4 weeks. The ureteric stents were removed under local anaesthesia for patients who have no residual fragments, while they were removed in the operating theatre for those who have residual stones, and a second session of fURS was performed to retrieve these residuals. The stone-free rate (SFR) was evaluated after 2 months with CTUT. Patients with non- significant residual stones (<4 mm) were followed up 3 months or 6 months. stone free rate, hospital stays ranged from 1 to 2 days and complications were assessed according to the modified Clavien scale were recorded.

Sample size:

The Sample size was calculated according to the following formula:

$$n = Z2\,P\,(1 - M) / d2$$

where, n = sample size, Z = Z statistic for a level of confidence (For the level of confidence of 95%, Z value is 1.96), P = expected prevalence or proportion (according to the significant difference between group D (Dusting) and group F (Fragmentation) regarding the results of fURS revealed where stone free rate was higher in group F (Fragmentation) compared to group D (Dusting) (44 (78.6%) vs. 30 (58.8%), P=0.035) according to previous study [8], so d = precision (0.05).

Four cases were added to overcome dropout. Therefore, 100 patients were allocated (50 patients in each group).

Statistical analysis:

Statistical analysis was done by SPSS v26 (IBM Inc., Armonk, NY, USA). Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of data. Quantitative parametric data were presented as mean and standard deviation (SD) and were analyzed by unpaired student t-test. Quantitative non-parametric data were presented as the median and interquartile range (IQR) and were analyzed by Mann Whitney-test. Qualitative data were presented as frequency and percentage (%) and analyzed using the Chi-square test or Fisher's exact test when appropriate. A two tailed P value $\leq$ 0.05 was considered statistically significant.

Results

Regarding patients' characteristics, Age, sex, BMI, ASA physical status, smoking, HTN and DM were insignificantly different between the studied groups Table 1.

Regarding stone size, stone side and recurrent stone disease were insignificantly different between the studied groups; there was an insignificant difference as regard Hounsfield scale between both groups Table 2

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Table 1: Patients characteristics of the studied groups

		Group A (n=50)	Group B (n=50)	P value
Age (years)	**Mean ± SD**	41.4 ± 12.32	41.6 ± 11.47	0.920
	Range	40 - 65	41 - 63	
Sex	**Male**	30 (60%)	28 (56%)	0.685
	Female	20 (40%)	22 (44%)	
BMI (Kg/m^2)	**Mean ± SD**	26.5 ± 2.68	26.4 ± 2.46	0.843
	Range	21.01 - 34.52	20.76 - 30.7	
ASA physical status	**ASA I**	29 (58%)	31 (62%)	0.683
	ASA II	21 (42%)	19 (38%)	
Smoking		12 (24%)	18 (36%)	0.190
HTN		13 (26%)	12 (24%)	0.817
DM		11 (22%)	10 (20%)	0.806

Data presented as mean ± SD or frequency (%), BMI: body mass index, ASA: American Society of Anaesthesiologists, ASA I: A normal healthy patient, ASA II: A patient with mild systemic disease, HTN: hypertension, DM: diabetes mellitus

Table 2: Stone and Renal Characteristics & Hounsfield Scale of Studied Groups

		Group A (n=50)	Group B (n=50)	P value
Stone length (mm)	**Mean ± SD**	1.6 ± 0.4	1.5 ± 0.5	0.452
	Range	1 – 2	1 - 2	
Stone side	**Right**	21 (42%)	19 (38%)	0.683
	Left	29 (58%)	31 (62%)	
Recurrent stone disease		17 (34%)	15 (30%)	0.668
Hounsfield scale	**>600**	753.26 ± 93.55	767.82 ± 61.76	0.536
	<600	398.08 ± 57.71	406.09 ± 59.70	0.646

Operative time the time from entrance of fURS till the insertion of Foly's urethral catheter was significantly shorter in group A compared to group B (P value <0.001). Intraoperative complications were insignificantly different between the studied groups Table 3.

fURS were significantly better in group B compared to group A (P value =0.022). Hospital stays, SWL, semi-rigid URS, second flexible and postoperative complications were insignificantly different between the studied groups Table 4

Table 3: Intraoperative data of the studied groups

		Group A (n=50)	Group B (n=50)	P value
Operative time (min)	**Mean ± SD**	73.9 ± 15.83	88.9 ± 19	**<0.001***
	Range	47 – 104	60 – 121	
Intraoperative complications		0 (0%)	3 (6%)	0.242

Data presented as median (IQR), *: statistically significant as P value <0.05.

Table 4: Postoperative data and follow up of the studied groups

		Group A (n=50)	Group B (n=50)	P value
Hospital stays (days)	**Mean ± SD**	1.46 ± 0.5	1.38 ± 0.49	0.423
	Range	1 - 2	1 – 2	
Results of fURS	**Stone free**	17 (34%)	30 (60%)	0.022*
	Insignificant residual (<4 mm)	24 (48%)	12 (24%)	
	Residuals (≥4 mm)	9 (18%)	8 (16%)	
SWL		2 (4%)	2 (4%)	1
Semi-rigid URS (Slipped to the ureter)		2 (4%)	1 (2%)	1
Second flexible		3(6%)	2(4%)	0.646
Conservative		2 (4%)	3(6%)	0.646
Postoperative complications	**Grade I**	4 (8%)	6 (12%)	0.835
	Grade II	0 (0%)	0 (0%)	
	Grade IV a	1 (2%)	2 (4%)	

Data presented as mean ± SD or frequency (%), fURS: flexible ureteroscopy, SWL: shockwave lithotripsy, URS: ureteroscopy, *: significant as P value ≤ 0.05.

Discussion

There are two primary surgical approaches to RIRS for ureteral and renal calculi: active removal of fragments using a basket or fragmentation of fragments into dust using a holmium laser to allow spontaneous passage. High-frequency and low-energy holmium laser cause stones to break into punctate fragments, a procedure called dusting.

The potential advantages of dusting include shorter operative times and lower operative costs. While fragmentation offers potential benefits such as improved stone clearance and reduced risk of residual stone fragments leading to subsequent treatment events, there is currently no standardized optimal surgical approach for fragment treatment after laser lithotripsy. Even the Endourology Excellence Panel (EDGE) consortium did not reach a clear consensus on the best approach [8].

Our study stated that the dusting technique had a significantly shorter operation time, whilst the fragmentation technique had a significantly better SFR. Both techniques have comparable safety, hospital stay and requirement for secondary procedures.

In agreement with our results, [9] compared the dusting efficiency and safety with basketing for treating renal stones ≤ 2 cm during flexible ureteroscopy (fURS). He found that the mean operative time was significantly lower in the dusting group than in the basketing group (43.1±11.7 minutes vs 60.5±13.4 minutes, p <0.05).

This agrees with [10] who showed that operation time was significantly longer for fragmentation (93.23 ± 27.20 vs 78.43 ± 30.08, p = 0.045).

According to our study, Intraoperative, postoperative complications were insignificantly different between the studied groups. Consistency with our study, El-Nahas and associates [4] concluded that the overall complication rates were comparable between the groups (P = 0.840).

As regarding stone free rate (SFR), our study stated that Results of fURS were significantly better in group B compared to group A (P value =0.022). In agreement with our results, [9] stated that the immediate SFR after surgery was significantly higher in the basketing group (76.8%) compared with the dusting group (55.7%, p=0.001). The SFR was also higher in the basketing group at 88.4 % vs. 78.3% (p=0.045) than in the dusting group after 1 month postoperatively. However, the SFR was higher and similar for both groups (88.8% in the dusting group vs

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90.2% in basketing group, P=0.719) during the follow-up period after 3 months postoperatively.

In contrast to our study, Yildirim and others [10] stated that the evaluation of the success rates after 3 months did show that patients in the dusting group had a higher rate of stone-free status when compared with the other group of cases (65.6 vs 87.1%, p = 0.043).

El-Nahas and associates [11] stated that the SFR of the dusting technique was significantly lower than fragmentation because of the inability to be sure that the stone is completely dusted to tiny fragments that are small enough to pass spontaneously without complications.

Regarding complications, postoperative complications were insignificantly different between the studied groups.

In agreement with our results, El-Nahas and associates showed that the overall complication rates were comparable between the groups (P = 0.840) [4]. Also, [12] have reported comparable complications rates (11.8% for fragmentation vs 9.9% for dusting).

Similarly, it was reported that no significant difference was found in complications of the dusting and fragmentation groups [13]. The main advantage of the stone dusting technique is the ability to complete the procedure by a single pass of the fURS that can be done over a guidewire. As previously stated, each method does have its own advantages and disadvantages. Thus, the question regarding which technique is better for treating renal stones remains controversial.

This study has limitations as this single-centre study with a relatively small sample size and the results may differ elsewhere. The small sample size may mask the statistical significance of important differences, such as complication rates and the need for secondary procedures. We excluded patients with urological infection and patients with congenital urogenital disorders.

Conclusions:

For fURS for renal stones, the dusting technique had a significantly shorter operation time, whilst the fragmentation technique had a significantly better SFR. Both techniques have comparable safety, hospital stay and requirement for secondary procedures.

We recommended that further studies are needed with multicentre cooperation to validate our findings, additional studies were needed to compare stone dusting and spontaneous passage vs fragmentation and active fragment retrieval using flexible ureteroscopy (fURS) for lower calyceal stones 1 to 2 cm.

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Conflict of Interest: Nil

List of abbreviations:

FURS	Flexible ureteroscopy
SWL	Shockwave lithotripsy
RIRS	Retrograde intrarenal surgery
YAG	Yttrium-aluminium-garnet
PCNL	Percutaneous nephrolithotripsy
PUT	Plain X-ray of the urinary tract
BMI	Body mass index
SFR	Stone-free rate
DM	Diabetes mellitus
HTN	Hypertension
ASA	American Society of Anaesthesiologists
CTUT	non-contrast enhanced computed tomography
EDGE	Endourology Excellence Panel

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