

Comparative Study Between Laser Lithotripsy Dusting Technique and Fragmentation Technique in Upper Ureteric Stones

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Abstract

Background: The prevalence of Ureteric calculi is estimated to be 12% to 14% in men and 6% in women. The question of which surgical technique is optimal remains controversial and should be determined. Theoretically dusting decrease operative time and the risk of ureteral injury by avoiding the use of the ureteral access sheath (UAS). Also, dusting reduces the procedure cost by avoiding the use of stone retrieval devices.

Aim and objectives: In order to compare the efficacy and safety of the low-energy, high-frequency stone dusting approach and the high-energy, low-frequency stone fragmentation technique as they pertain to laser lithotripsy for upper ureteral stones.

Patients and methods: This prospective randomized trial was conducted on patients with upper ureteric stones and was divided into 2 groups. Group A consisted of twenty-five individuals who were subjected to dusting. The second group, known as group B, consisted of 25 patients and was subjected to Fragmentation. From June 2023 to May 2024, at the Urology Department of Al-Hussein and Sayed Galal, Al-Azhar University Hospitals in Cairo, Egypt.

Results: No perioperative complications were encountered. Stone clearance was observed in 23 (92%) & 16 (64%) patients in both groups, respectively (P 0.016). All patients with residual fragments required ancillary procedure.

Conclusion: The setting of energy and frequency have a considerable effect on stone free rate. The stone dusting technique during laser lithotripsy for upper ureteric stones is associated with lower residual stone rates and a reduced need for ancillary procedures compared to the stone fragmentation technique, while maintaining a similar safety profile. Our findings suggest that the dusting technique may be a preferred approach for the management of upper ureteric stones.

Keywords: Laser Lithotripsy Dusting Technique; Fragmentation Technique; Ureteric Stones

1. Introduction

The prevalence of Ureteric calculi is estimated to be 12% to 14% in men and 6% in women.¹ Theoretically, dusting decreases operative time and the risk of ureteral injury by avoiding the use of the ureteral access sheath (UAS). Also, dusting reduces the procedure cost by avoiding the use of stone retrieval devices.²

The management options for upper ureteric stones are medical expulsive therapy (MET) with paucity of data on its effectiveness; Primary

options include ESWL and URS. Last, laparoscopic and robotic uretero-lithotomy.³ The rate of residual stones and stone migration to the kidney is higher in the fragmentation technique.⁴

The current study's objective is to compare the safety and efficacy, of the high energy and low frequency stone fragmentation approach with the low energy and high frequency stone dusting technique during laser lithotripsy in upper ureteric stones.

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2. Patients and methods

This prospective randomized trial was conducted at Al-Hussein and Sayed Galal Urology Departments of Al-Azhar University Hospitals in Cairo, Egypt, between June 2023 and May 2024. It included patients with single or multiple upper ureteric stones < 2.5 cm at both genders and at any age who were not suitable for medical expulsive therapy or ESWL, with exclusion of patients with coagulation disorders, active urinary tract infection at presentation, and patients with congenital anomalies of the urinary system.

Using the 2015 version of the random number generator application, fifty patients were randomly allocated into two groups. Group A consisted of twenty-five individuals who were subjected to dusting with low energy (0.5 J) and high frequency (15-20 Hz). Group B consisted of 25 patients and used lower frequencies (5Hz) and higher energy levels (1-1.5J).

Procedure:

All patients were subjected to semi-rigid or flexible ureteroscopy(fURS) by the standard procedure under spinal or general anesthesia. After visualization of the stone group, Group A underwent dusting with low energy (0.5 J) and high frequency (15-20 Hz), and Group B underwent Fragmentation with lower frequencies (5Hz) and higher energy levels (1-1.5J) using the holmium YAG laser. Any intraoperative incidents were recorded. Once the stone fragmentation or dusting process is finished, either a ureteric catheter or a DJ stent is inserted according to the operator's judgment. After surgery, patients were monitored for 24 hours for any signs of pain in the loins or abdomen, fever, or blood in the urine, and underwent X-Ray KUB, and the ureteral catheter was withdrawn before discharge. Antibiotic treatment persisted for a further three to seven days following discharge. Patients were scheduled for a follow-up visit at 2 weeks with urine analysis and X-Ray KUB in radiopaque stones or a visit at 1 month with urine analysis and NCCT in radiolucent stones.

Statistical analysis:

We used SPSS v26 (IBM Inc., Armonk, NY, USA) for our statistical reporting and analysis. The unpaired Student's t-test was used to compare the two groups' quantitative variables, which were given as means and standard deviations (SD). The Chi-square test or Fisher's exact test was used to assess qualitative variables, which were provided as percentages and frequencies. One dependent variable and one independent variable are the main foci of univariate linear regression. Statistical significance determined by P-value <0.05.

3. Results

Table 1. The patient's demographics

		DUSTING-GROUP (N=25)	FRAGMENTATION-GROUP (N=25)	P VALUE
AGE (YEARS)	Mean ± SD	42.6 ± 13.18	41.4 ± 12.26	0.740
	Range	7 - 69	8 - 64	
GENDER	Male	21 (84 %)	19 (76 %)	0.479
	Female	4 (16 %)	6 (24 %)	
STONE-SIZE (MM)	Mean ±SD	12.7±3.12	12.8±3.18	0.858
	Range	8-20	9-20	
STONE-BURDEN*	Mean ±SD	13.5±3.29	13.6±4.53	0.943
	Range	8-20	9-28	
STONE-DENSITY (HU)	Mean ±SD	1062.6±336.07	1174±312.17	0.231
	Range	400-1600	500-1750	
HUN	Non	7 (28 %)	8 (32 %)	0.884
	Mild	9 (36 %)	7 (28 %)	
	Moderate	8 (32 %)	8 (32 %)	
	Marked	1 (4 %)	2 (8 %)	
PRE-OPERATIVE DJ STENTING	Yes	6 (24 %)	3 (12 %)	0.269
	No	19 (76 %)	22 (88 %)	

*Stone-burden is the sum of the longest axial diameter of all stones

There was no discernible difference between the patient's demographics

Mild intra operative bleeding was encountered in 6 (24 %) & 3 (12%) patients in both groups respectively however the procedure was completed safely. Extended operative time interfere with completion of the procedure and need for a second session in one patient in dusting group. One patient in fragmentation group had a stone migrated to the kidney but was successfully tacked and fragmented. Ureteric perforation was reported in 3 patients in fragmentation group.

Table 2. Intra operative complications in the studied groups

		DUSTING-GROUP (N=25)	FRAGMENTATION-GROUP (N=25)	P VALUE
INTRA-OPERATIVE COMPLICATIONS	Non	18(72%)	18(72%)	NS*
	Mild bleeding	6(24%)	3(12%)	
	Migration of stone to kidney	0(0%)	1 (4 %)	
	Long intra operative time for 2nd stage	1(4%)	0(0%)	
	Ureteral perforation & extravasation	0(0%)	3(12%)	

*Non-significant difference

Table 3. Type of URS

		DUSTING-GROUP (N=25)	FRAGMENTATION-GROUP (N=25)	P-VALUE
TYPE OF URS	Flexible	9(36%)	4(16%)	0.107
	Rigid	16(64%)	21(84%)	

Type of URS was insignificantly different between both groups.

Table 4. Pre-operative KUB and DJ stenting

		DUSTING-GROUP (N=25)	FRAGMENTATION-GROUP (N=25)	P VALUE
PRE-OPERATIVE KUB	Radiopaque	22(88%)	21(84%)	0.689
	Radiolucent	3(12%)	4(16%)	
PRE-OPERATIVE DJ STENTING	Yes	6(24%)	3(12%)	0.269
	No	19(76%)	22(88%)	

KUB: kidney, ureter, and bladder X-ray, DJ: Double J.

Pre-operative KUB and pre-operative DJ stenting were insignificantly different between both groups.

Table 5. The post-operative imaging finding

		DUSTING-GROUP (N=25)	FRAGMENTATION-GROUP (N=25)	P VALUE
POST-OPERATIVE KUB	DJ Stent	18(72%)	21(84 %)	0.671
	Ureteric catheter	7(28%)	4(16%)	
	Residual stones	5(20%)	12(48%)	0.036*
2 WEEKS POST-OPERATIVE KUB	Residual stone	2(8%)	8(32%)	0.033*
POST-OPERATIVE NCCT	LT DJ Stent	1(4%)	3(12%)	0.502
	RT DJ Stent	2(8%)	1(4%)	
	No	22(88%)	21 (84%)	
	Residual stone	0(0%)	3(12%)	0.050*

LT: Left, RT: Right, Bil: Bilateral, NCCT: Non-contrast computerized tomography,

NAD: No abnormality detected.

Regarding residual stones in Post-operative KUB and 2 weeks post-operative KUB, Dusting group had lower residual stones compared to fragmentation group (P=0.036,0.033).

Regarding residual stones in Post-operative NCCT, Dusting group had lower residual stones compared to fragmentation group (P=0.050).

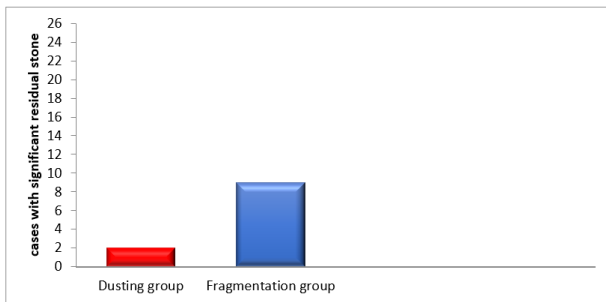


Figure 1. cases with significant residual stone.

Table 6. The post-operative complications

		DUSTING-GROUP (N=25)	FRAGMENTATION-GROUP (N=25)	P VALUE
POST-OPERATIVE COMPLICATIONS	NAD	19(76%)	14(56%)	NS
	Fever	2(8%)	2(8%)	
	Hematuria	1(4%)	2(8%)	
	Renal colic	3(12%)	6(24%)	
	UTI	0(0%)	1(4%)	

Post-operative complications was insignificantly different between both groups

Table 7. Clinical significant residual stone, and need for ancillary procedure

		DUSTING-GROUP (N=25)	FRAGMENTATION-GROUP (N=25)	P VALUE
CLINICAL SIGNIFICANT RESIDUAL STONE	Yes	2(8%)	9(36%)	0.016*
	No	23(92%)	16(64%)	
NEED FOR ANCILLARY PROCEDURE	No	23(92%)	16(64%)	0.032*
	ESWL	1(4%)	3(12%)	
	URS/F.URS	1(4%)	6(24%)	

Clinical significant residual stone, and need for ancillary procedure significantly lower in dusting group. Patient is consider stone free when no radiopaque shadow in x-ray in radiopaque stones and stone <4mm in NCCT in radiolucent stones.

4. Discussion

Fifty patients presenting upper ureteral stones to the urology departments of Al-Hussein and Sayed Galal, Al-Azhar University Hospitals, were the subjects of this prospective study. One group

was given the task of dusting, and the other was given the task of Fragmentation. There were 25 participants in each group.

The people in our study groups were a good mix of age, gender, history of urological surgery, creatinine levels, clinical appearance, stone side, stone size, stone burden, stone number, stone density, and the amount of HUN that people had at the start of the study. Because the groups are so similar, any changes in outcomes can be traced back to the lithotripsy method and not to other factors that could have caused them.

Chen et al.⁶ studied the results and effectiveness of ureteral stone therapy using dusting laser URS versus fragmentation laser URS. They concluded that the two groups were statistically indistinguishable.

Chen et al.⁵ patients with pyuria and multiple ureteral stones were more common in the dusting group compared to the fragmentation group, according to the findings. The likelihood of having a lower stone-free rate increased significantly when there were multiple stones. The positioning of stones also plays a major role in stone clearance. Comparing patients with stones in other parts of the urinary tract to those with stones in the upper ureter demonstrated a substantially lower stone-free rate.

The two groups employed similar ureteroscopes (flexible or semi-rigid) depending on availability, and both groups had similar rates of pre-operative DJ stent. By standardizing these characteristics, we were able to compare the two lithotripsy treatments fairly.

Our study's most important finding was that, in contrast to the fragmentation group, the dusting group had significantly reduced residual stone rates. The results showed this in the following groups: post-operative KUB (20% vs. 48%, p=0.036), 2-week post-operative KUB (8% vs. 32%, p=0.033), and post-operative NCCT (0% vs. 12%, p=0.050). Based on these findings, it seems that dusting is the better method for completely clearing stone than Fragmentation.

Previous studies have found that the dusting procedure results in lower residual stone rates.

Chen et al.⁵ findings showed that, in comparison to the fragmentation group, the dusting group had a considerably lower stone free rate and a greater stone push back rate. There was no statistically significant relationship between the laser mode and the stone-free rate in the multivariate study.

AL Sunboli et al.⁷ reported that a higher need for the DJ stent was in the fragmentation group.

Earlier this year, researchers from Elzayat et al.⁸ determined that stone-free rates were 90% in the dusting group 90% and 75% in the fragmentation group 75%.

Ashmawy et al.⁹ demonstrated a stone-free rate of 91.66 % when the dusting method was used.

According to Kortenbergh and Traxer,¹⁰ "In the instance of impacted ureteral stones, which generate smaller stone fragments (dusting influence), the "high frequency, and low voltage" option is more appropriate for micro stone fragmentation. Though it lengthens the surgery and might not work for harder stones, "reduced voltage" has the added benefit of reducing mucosal injury.

Researchers from Jodi et al.⁴ saw a decrease in stone migration in the group that was dusting as compared to the group that was fragmenting.

El-Nahas et al.¹¹ in an effort to evaluate the efficacy of stone dusting, spontaneous passing, Fragmentation, and active fragment retrieval as methods for detecting renal calculi during fURS. They found that compared to the dusting group, the fragmentation group had a considerably higher stone-free rate (SFR) of 78.6%.

Humphrey et al.¹² findings of SFR (74.3% for basketting and Fragmentation vs. 58.2% for dusting, $P=0.004$). When KUB and renal ultrasonography revealed no measurable fragment remnants, they deemed this a successful SFR. Lee et al.¹³ reported an SFR for dusting of 86.8%, while 89% for Fragmentation.

Chen et al.⁶ found that, in comparison to the fragmentation group, the dusting group's stone retropulsion rate was substantially higher. Despite the high rate of resistance in the dusting group, neither the stone-free rate nor the rate of further intervention was significantly affected. We took this to mean that the retro-pulsed stones were meaningless, didn't require any further treatment, and probably didn't have much of an impact on the stone-free rate.

There was no statistically significant difference in the amount of time patients spent in the hospital in our study.

This agrees with Gauhar et al.¹⁴, who demonstrated that there was no statistically significant variation in the duration of hospital stays following surgery ($p=0.36$).

In our study, we found that the two groups had identical rates of intraoperative problems, suggesting that the two procedures were equally safe. The groups also showed no significant difference in postoperative complications, as measured by the Clavien grading system.

In contrast to the fragmentation group, the dusting group had a considerably lower incidence of clinically unimportant residual stones (<4 mm) (8% vs. 36%, $p=0.016$) and a reduced necessity for auxiliary operations (8% vs. 32%, $p=0.032$). These results provide more evidence that the dusting method is superior for stone clearing.

A recent study by Elzayat et al.⁸ identified a 15% incidence of postoperative problems in the dusting group and a 20% incidence in the fragmentation group.

A study conducted by Jodi et al.⁴ claimed that the dusting group caused less damage to the mucosa than the fragmentation group.

El-Nahas et al.¹¹ revealed that, out of all the surgical procedures performed, only two ureteric perforations (a Grade 3 injury according to Traxer and Thomas grading systems) occurred in the fragmentation group. Due to the lack of a statistically significant difference in the complication rates (8.9% for Fragmentation vs 7.8% for dusting, $P=0.840$), the two procedures were deemed to be equally safe.

Lee et al.¹³ the incidence of problems were 11.8% for Fragmentation and 9.9% for dusting, which are similar.

Humphrey et al.¹² were found to have similar rates of problems amongst the groups treated with dusting and Fragmentation.

Chew et al.¹⁵ investigated the evolution of post-FURS pieces. A secondary intervention was necessary for 29% of patients, and the dusting and fragmentation methods did not differ significantly in this regard.

Wael et al.¹⁶ reported stone free rate 89% of the fragmentation group and 86% of the dusting group.

Gauhar et al.¹⁴ showed no statistically significant difference between the groups with respect to total complications ($p=0.95$), hematuria ($p=0.99$), postoperative fever ($p=0.19$), sepsis ($p=0.98$), immediate problems ($p=0.11$), and retreatment rate ($p=0.49$).

4. Conclusion

Setting the energy and frequency has a significant effect on the stone-free rate.

The stone dusting technique during laser lithotripsy for upper ureteric stones is associated with lower residual stone rates and a reduced need for ancillary procedures compared to the stone fragmentation technique, while maintaining a similar safety profile.

Our findings suggest that the dusting technique may be a preferred approach for the management of upper ureteric stones.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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There are no conflicts of interest.

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