AUA 2020 Abstract's publication number: PD01-07

Size distribution of fragments by MOSES technology holmium laser lithotripsy: a prospective analysis of 110 cases

Naveen Reddy M, Gopal Tak, Abhijit Patil, Nadiad, India; Mihir Desai, Los Angeles, CA; Abhishek Singh, Arvind Ganpule, Ravindra Sabnis, Mahesh Desai, Nadiad, India.*

AIM

- **Basket extraction** of all possible stone fragments after PCNL or RIRS has been shown in recent studies to **increase stone clearance** and recurrence.
- However, **data are lacking on the distribution of size of fragments** formed with different laser settings and stone density and composition that may impact the ability to successfully basket such fragments.
- Dust (< 1mm) and small fragments (1-3 mm) may be too small to be efficiently basketed compared to larger fragments (> 3mm). In this study we report size distribution of fragments created with various energy settings during holmium laser lithotripsy.

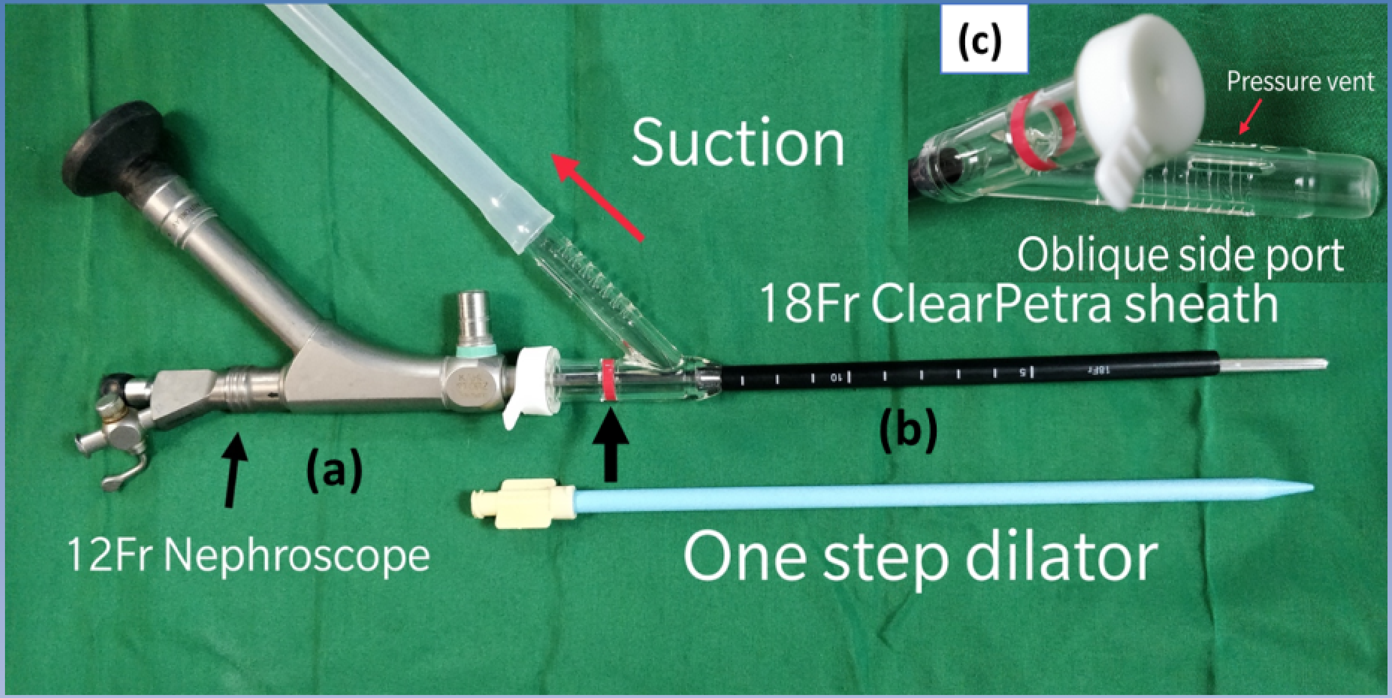
METHODS

- 110 patients with renal calculi underwent Mini-PCNL using a novel sheath system (ClearPetra, Well Lead, China) that incorporates a controllable irrigation and suction system minimizing the fragment dispersion and maximizes fragment aspiration during the procedure.
- **Study period**: from July 2018 to Oct 2019.
- **Inclusion criteria**: Renal stones <3cm, Age > 18 years and normal upper tract anatomy.
- **Exclusion criteria**: Patients with significant comorbidity precluding general anaesthesia, solitary functioning kidney, presence of ureteral calculi or strictures, untreated UTI, and pregnant females were excluded from the study.

- Stone size was defined as the maximum length of the stone on a preoperative computed tomography (CT). For multiple stones stone size was defined as sum of maximum diameter of individual stones.
- Stone volume was calculated using 3D doctor imaging software from CT images. Stone Hounsfield units (HU) was determined by drawing a region of interest around the calculus using CT work station software.
- The lasing time and operative time were defined as the total duration of laser usage and from the time of percutaneous endoscopy to exit respectively.
- The stone fragmentation rate is defined as the stone volume divided by lasing time.
- The stone clearance was defined as absence of any stone fragment on post operative NCCT

- All patients underwent NCCT KUB(Non Contrast Computed tomography of Kidney Ureter and Bladder region) within 48 hours of the procedure to assess the stone free status.
- At 30 days follow up, NCCT was done only for those patients with residual stones in the immediate post operative period.
- The factors influencing creation of baskettable (> 3mm) fragments were assessed using multivariable regression analysis. Sensitivity analysis according to stone composition and stone clearance was also performed.

Shows instrumentation used for the miniPCNL

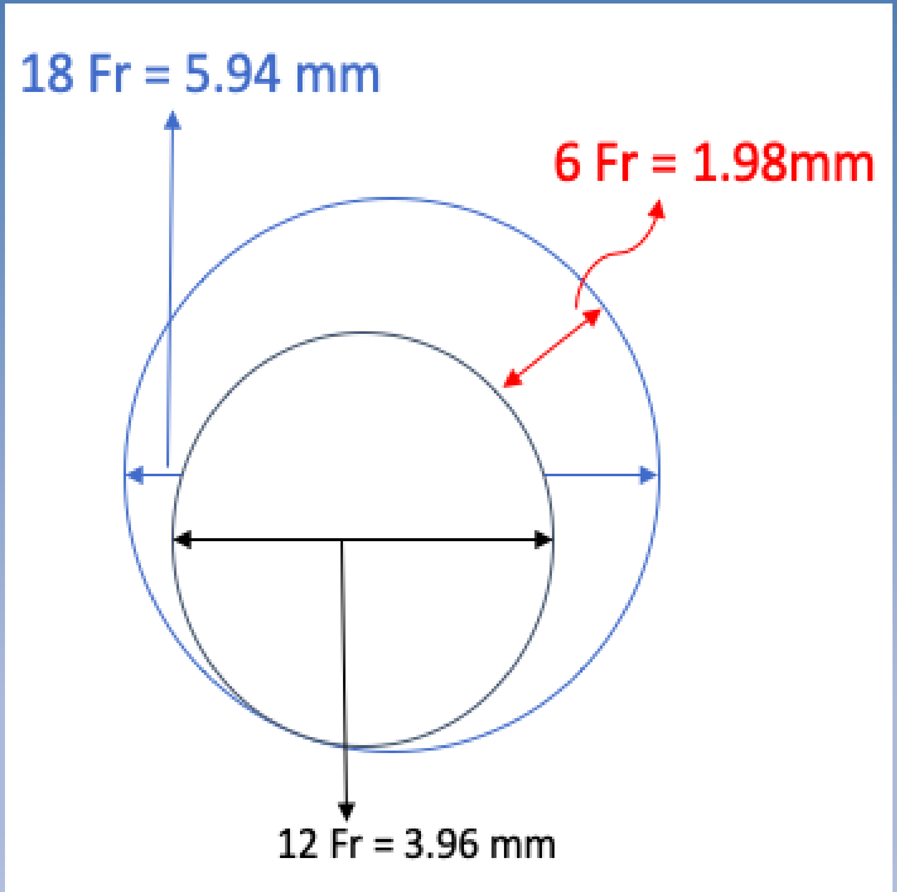


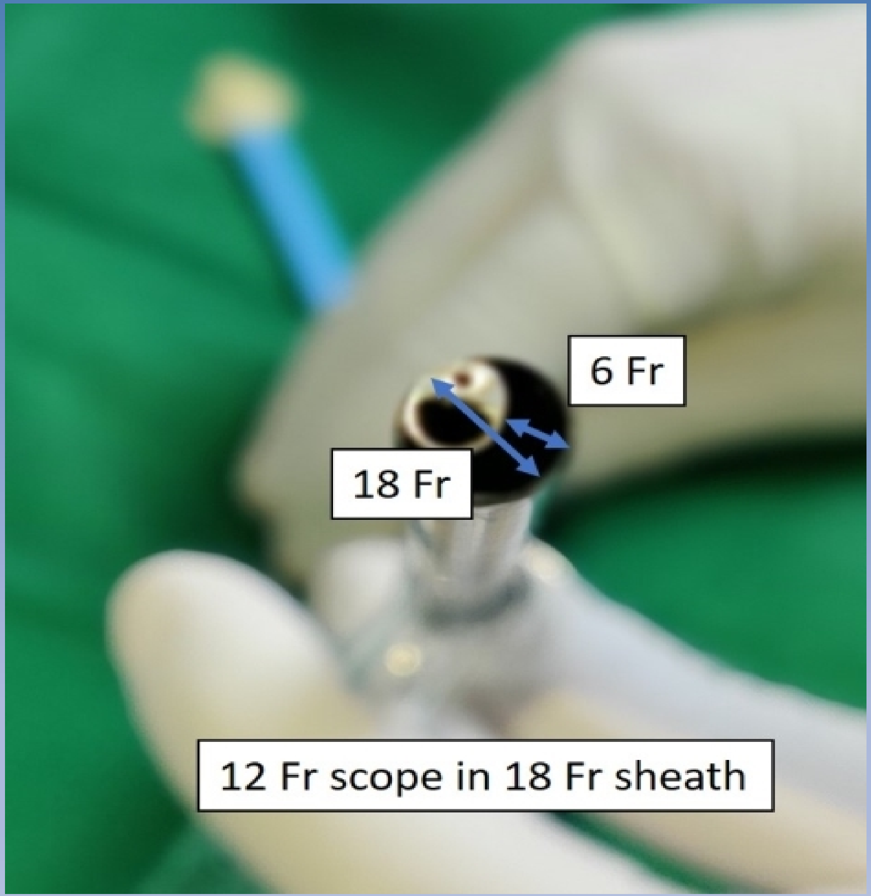
- (a) 12 Fr nephroscope which passes through (b) 18Fr ClearPetra nephrostomy suction sheath. **The red mark (thick arrow) indicates the point until where the nephroscope has to be withdrawn for suctioning large fragments. The oblique offset suction port is shown(c) with suction vent which can be controlled by surgeon to control suction pressure**. The nephrostomy sheath is inserted over single step dilator.

Holmium Laser Lithotripsy Machine: MOSES Pulse 120H Lumenis

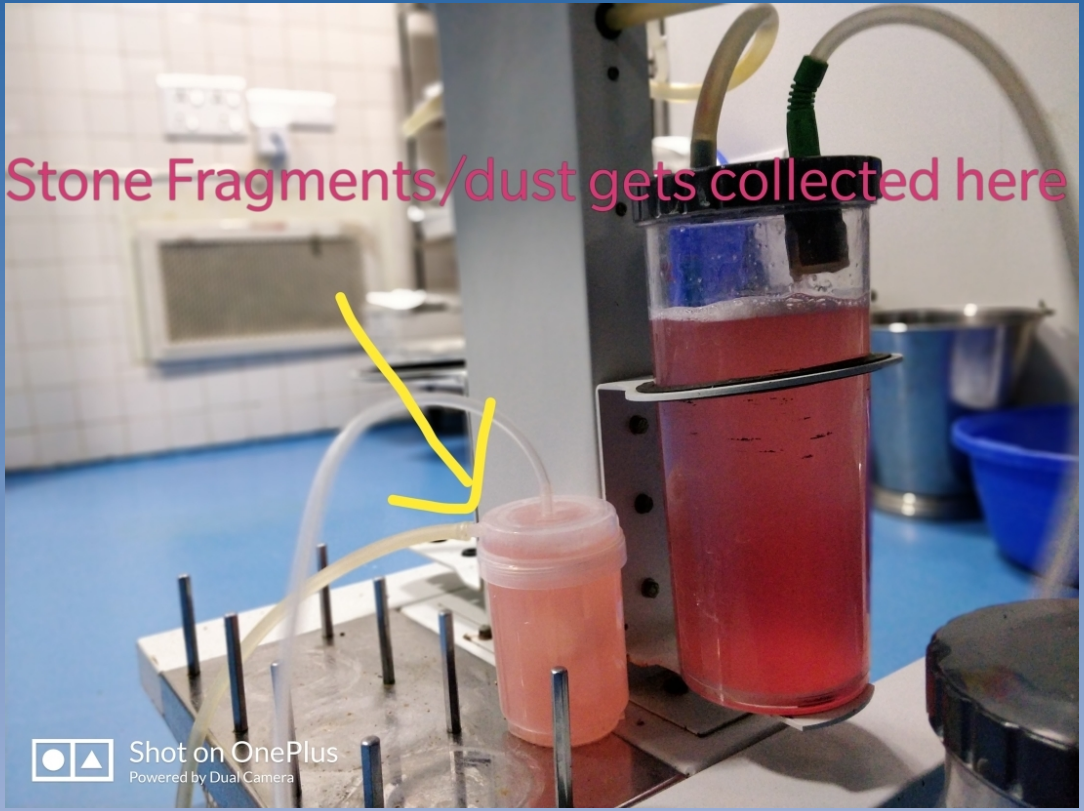
- The 120W Moses Holmium laser (Lumenis) was used with various combinations of energy settings to perform lithotripsy with 365 μm laser fiber.
- In 57 cases only a single energy setting was applied and in 53 cases multiple settings were applied in the same case

18 Fr sheath with 12 Fr Nephroscope





- The suction port of the nephrostomy sheath was connected to a negative pressure aspirator in continuous mode set at 150-200mmHg.
- Continuous irrigation inflow through the nephroscope was set at 50-100ml/min at room temperature.



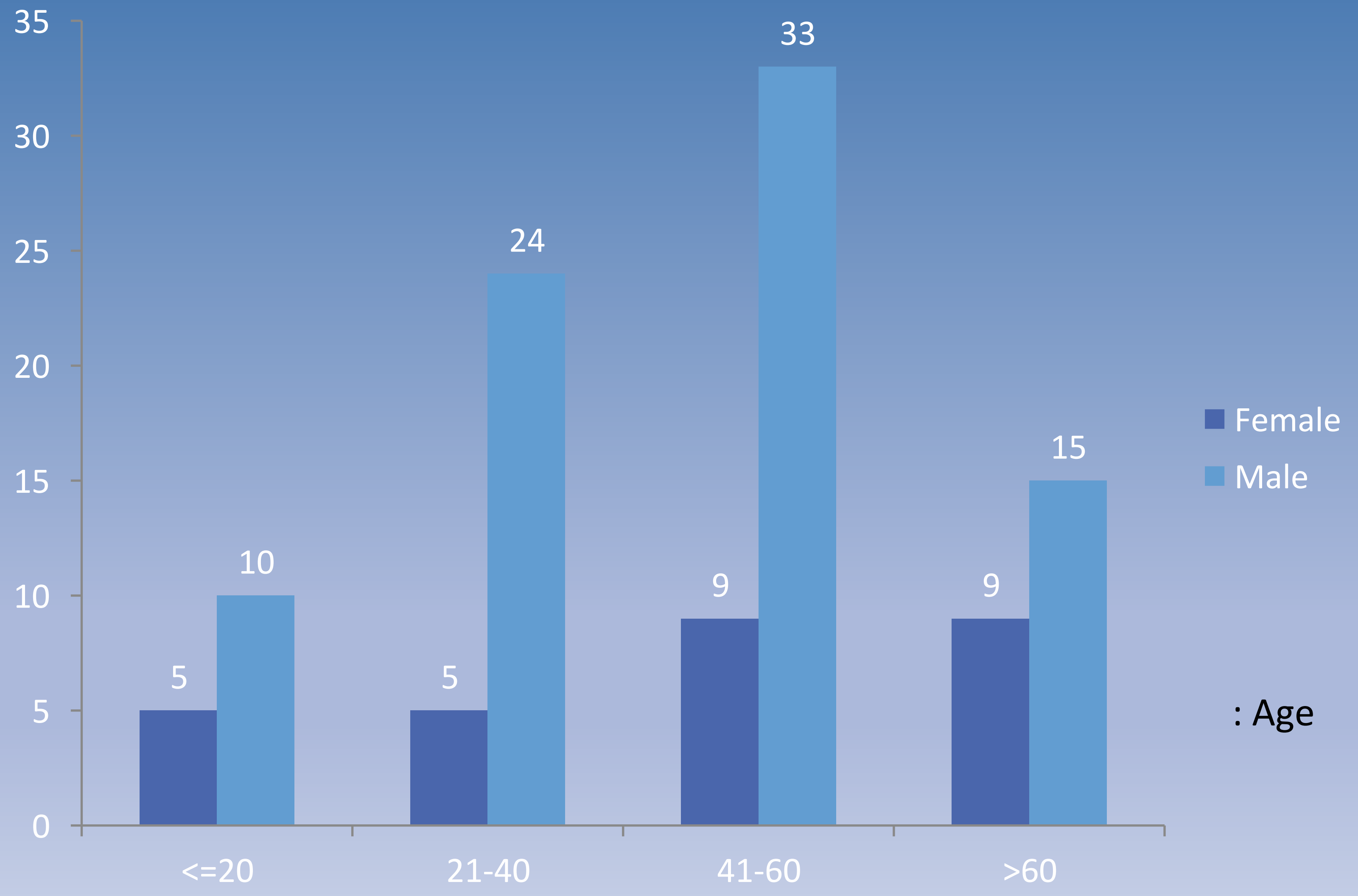
- All fragments were collected in a strainer incorporated in the aspiration system .
- The collected fragments were dried, separated manually, weighed and divided according to their size into dust (<1mm), small (1-3 mm) and large (>3 mm) fragments (Separately, if different energy settings were used in one patient).

RESULTS

- Laser settings ranged from various combinations of frequency (20-80 Hz) and power (0.3-1.2 J).
- Using multivariable regression analysis, Frequency, energy and power were all predictive for proportion of creating > 3 mm fragments ($P<0.05$).
- The average efficiency of fragmentation was 5.5 mm^3 /sec and was not associated with any factor on multivariable regression.
- Complete stone clearance at 48 hours was achieved in 77.27% cases. The residual fragments in the remaining 22.73% were ranging from 1-6mm. 98 % patients completed one month follow-up (2% lost for follow up) and had 100% stone clearance on CT KUB.

Demography: Age and Sex

Total no of cases : 110
Male: 82
Female: 28



Various Parameters

Parameter	Mean ± SD
Age (years)	44.6 ± 18.15
Male (n)	82
BMI (kg/m^2)	23.09 ± 4.50
Stone diameter (mm)	17.5±8.9
Stone volume (mm^3)	3963.89 ± 2939.93
Stone density (HU)	1140 ± 287.02
Stone Location n (%)	
Upper calyx	8 (7.2)
Middle calyx	9 (8.2)
Lower calyx	19 (17.3)
Pelvis	74 (67.3)
Stone number n (%)	
Single	106 (96.4)
Multiple	4 (3.6)
Operative time(min)	38.55 ± 13.48
Laser time (minute)	7.9 ± 7.4
Stone fragmentation rate(mm^3/s)	5.65 ± 5.11
Energy Consumed (KJ)	34.89 ± 24.11
Hb drop (g/dl)	1.1 ± 0.78

- Several factors other than the laser settings such as stone density, stone composition and its also its internal crystalline structure may play a role in the nature of fragmentation of a particular stone.

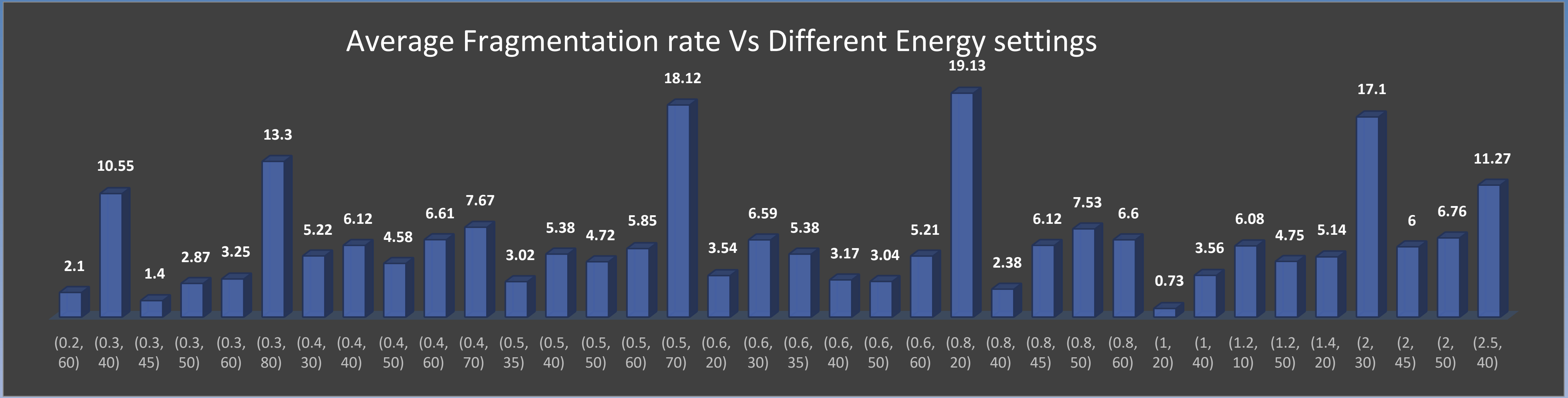
Stone Volume Vs other parameters

Volume (mm^3)	Stone Density (HU)	Total Energy (KJ)	Laser Time (Sec)	Stone frag. rate (mm^3 /sec)	1mm> (%)	1mm > (gm)	1-3mm (%)	1-3mm (gm)	3mm< (%)	3mm < (gm)
1000=>	969.54	7.09	486.62	6.178	50.15	0.13	30.14	0.07	19.71	0.05
1000-2000	1192.13	12.12	385.27	3.823	37.91	0.16	29.52	0.12	32.58	0.12
2000-3000	1275.47	25.62	932.2	3.69	43.42	0.27	30.89	0.19	25.28	0.14
3000-4000	1191.83	22.22	462.5	7.15	39.75	0.44	29.48	0.19	30.89	0.23
Above 4000	1226.5	74.68	1224.19	7.98	44.48	0.82	26.67	0.40	28.83	0.39

Stone Density Vs other parameters

Density (HU)	Stone Vol	Total Energy (KJ)	Laser Time(in Sec)	Stone frag. rate (mm^3 /sec)	1mm> (%)	1mm > (gm)	1-3mm (%)	1-3mm (gm)	3mm< (%)	3mm < (gm)
Less than 600	578.57	5.77	486.67	5.91	50.08	0.07	34.4	0.05	14.32	0.02
600-800	11319.93	33.12	477.4	6.63	50.47	0.12	27.4	0.11	22.13	0.16
800-1000	5345.23	43.54	1263.27	5.02	44.59	0.46	32.66	0.33	22.81	0.19
1000-1200	2574.35	14.15	499.09	6.41	40.04	0.21	30.98	0.13	28.97	0.13
1200-1400	3840.20	23.24	593.10	6.01	49.03	0.37	27.89	0.16	22.9	0.16
Above 1400	3063.09	27.23	636.65	3.96	46.17	1.30	28.68	0.13	25.15	0.14

AVERAGE FRAGMENTATION RATE VS DIFFERENT ENERGY SETTINGS

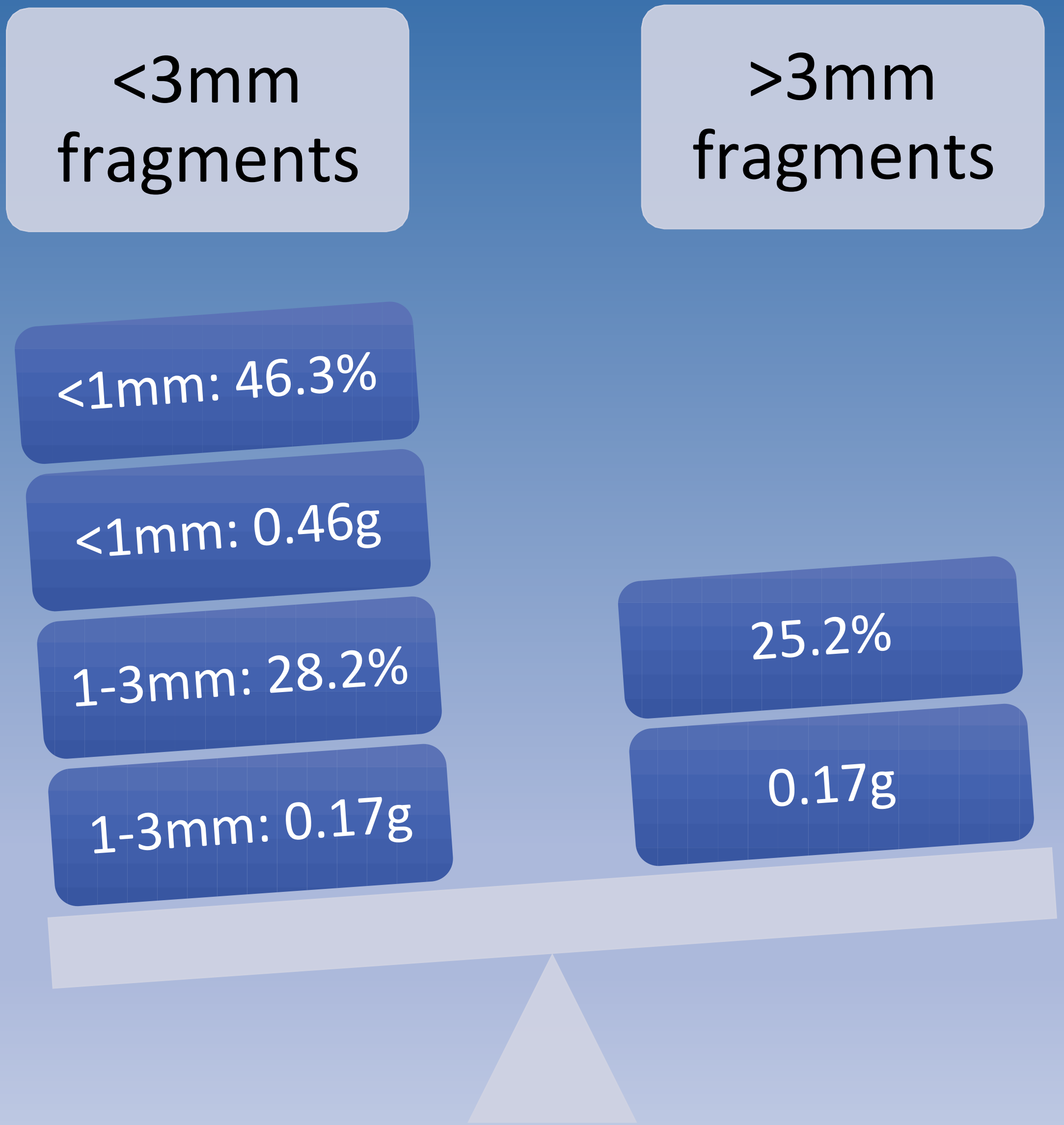


Small residual fragments do matter

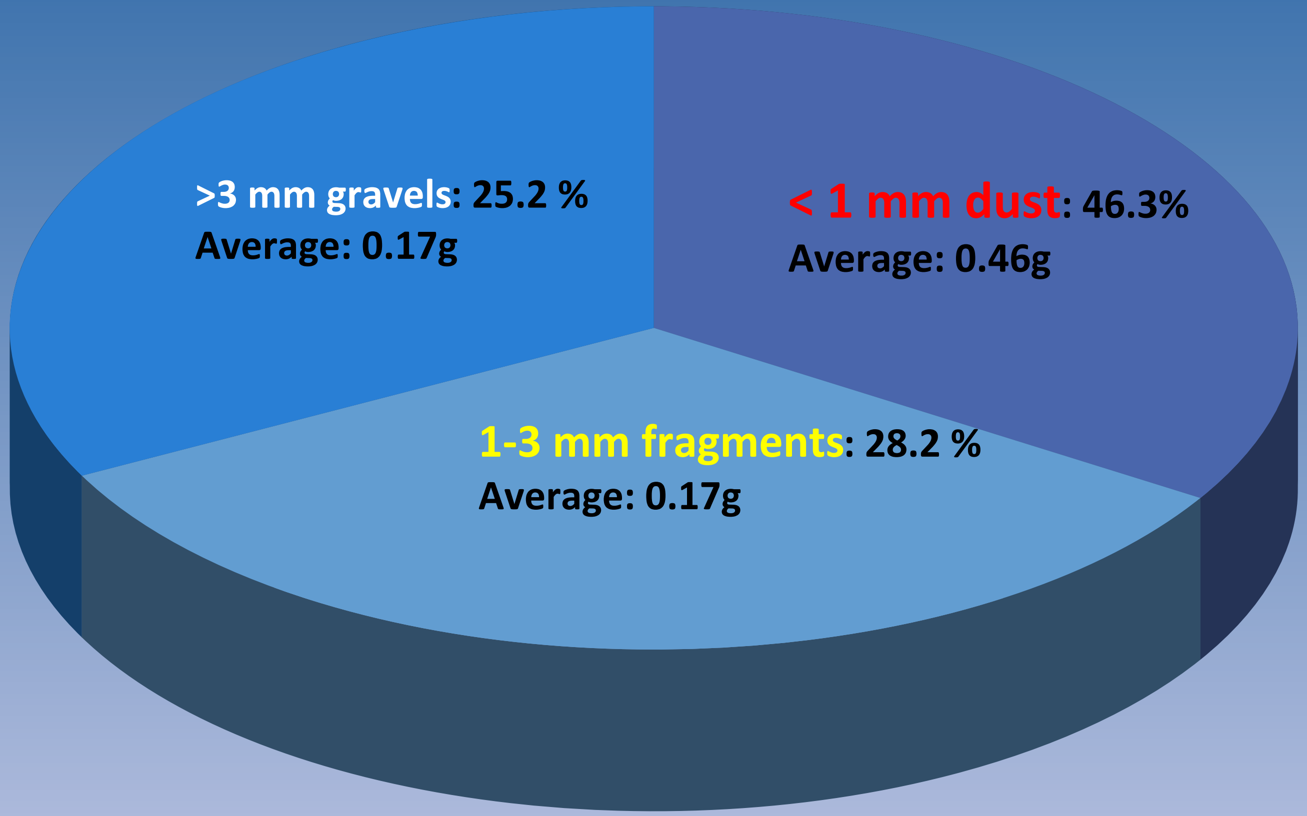
- Portis et al assessed long-term outcomes in 129 patients undergoing PCNL with a mean follow-up of 5.4 years[1]
- Bhattu et al mentions that patients who were completely stone-free had a lower rate of a repeat procedure (4%) whereas **those with RF >2 mm or even <2 mm, had repeat procedure rates of 30% and 33%** respectively [2].
- This implies that even small RFs <2 mm may have significant consequences, and that a **zero-fragment outcome has the most desirable result** [1]

1. Portis AJ, Laliberte MA, Tatman P, Lendway L, Rosenberg MS, Bretzke CA. Retreatment after percutaneous nephrolithotomy in the computed tomographic era: long-term follow-up. Urology. 2014;84(2):279–84.
2. Bhattu AS, Mishra S, Ganpule A, Jagtap J, Vijaykumar M, Sabnis RB, et al. Outcomes in a large series of minipercs: analysis of consecutive 318 patients. J Endourol. 2015;29(3):283–7.

All cases taken together, Average % of stone fragments



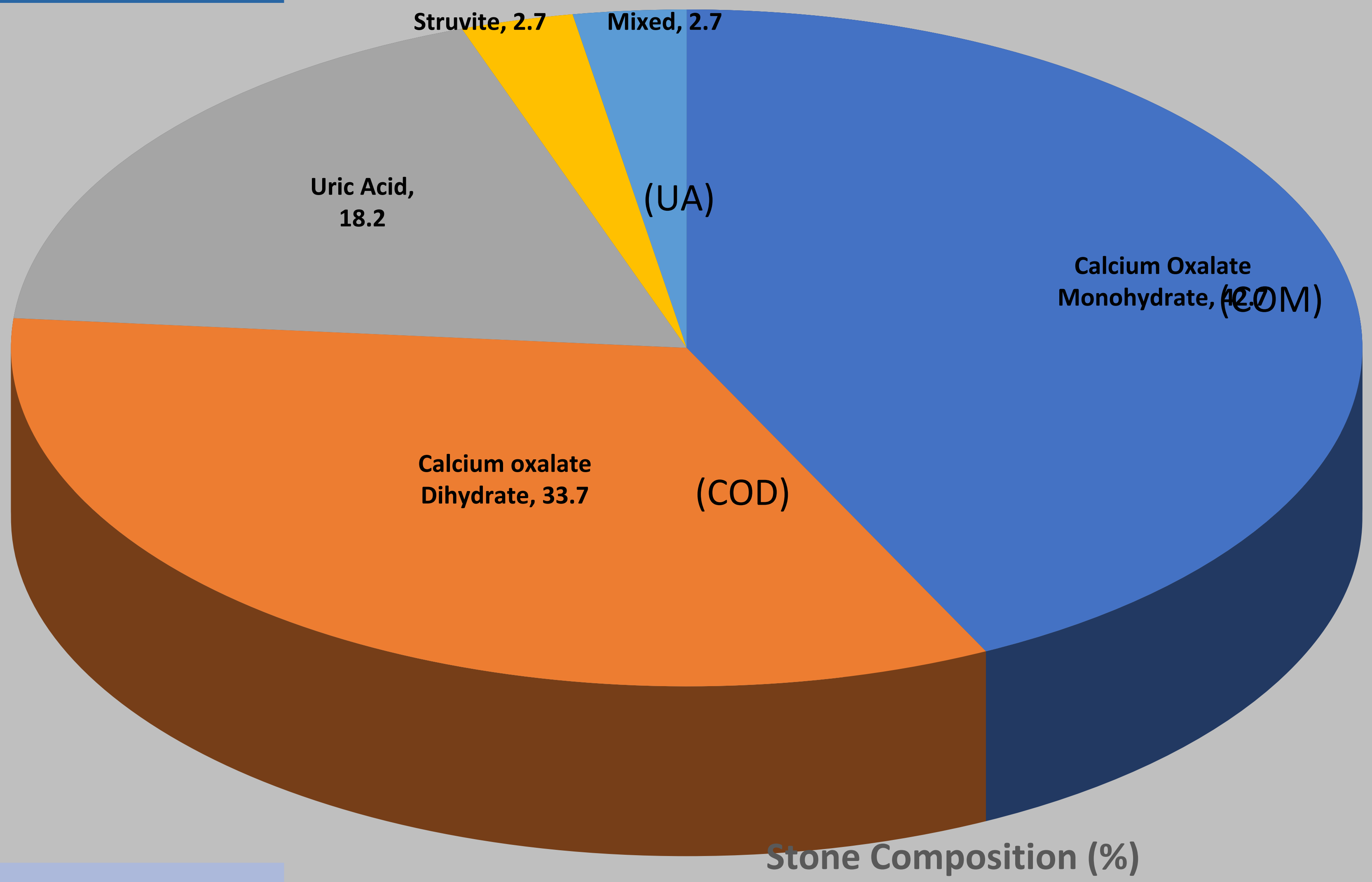
Proportion of the stone fragments



Stone fragment size distribution (%)	Mean±SD
<1mm (%)	46.36 ± 16.68
1-3mm (%)	28.18 ± 10.01
>3mm (%)	25.19 ± 16.18

S

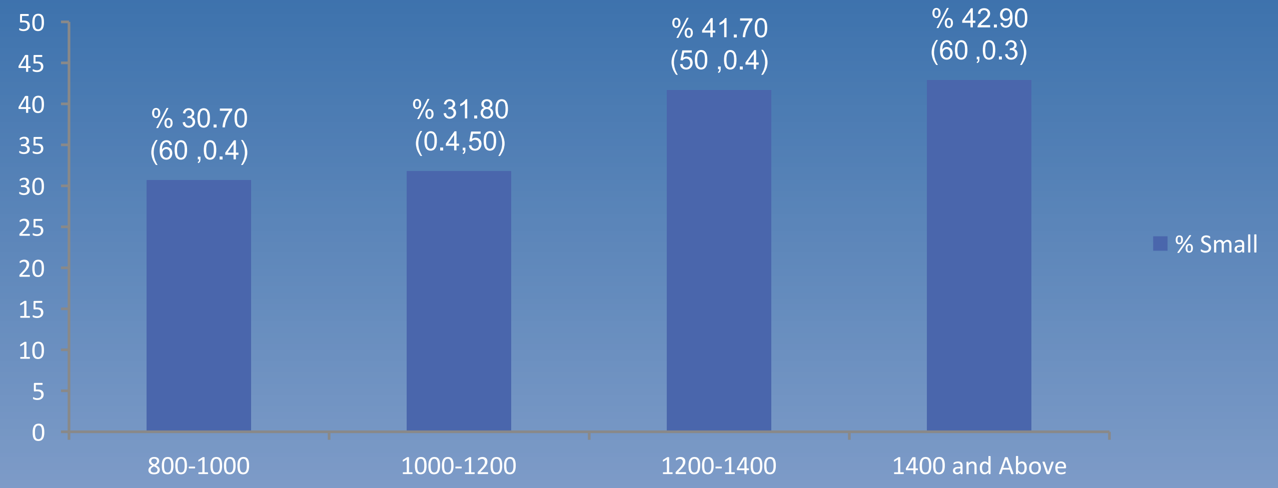
C



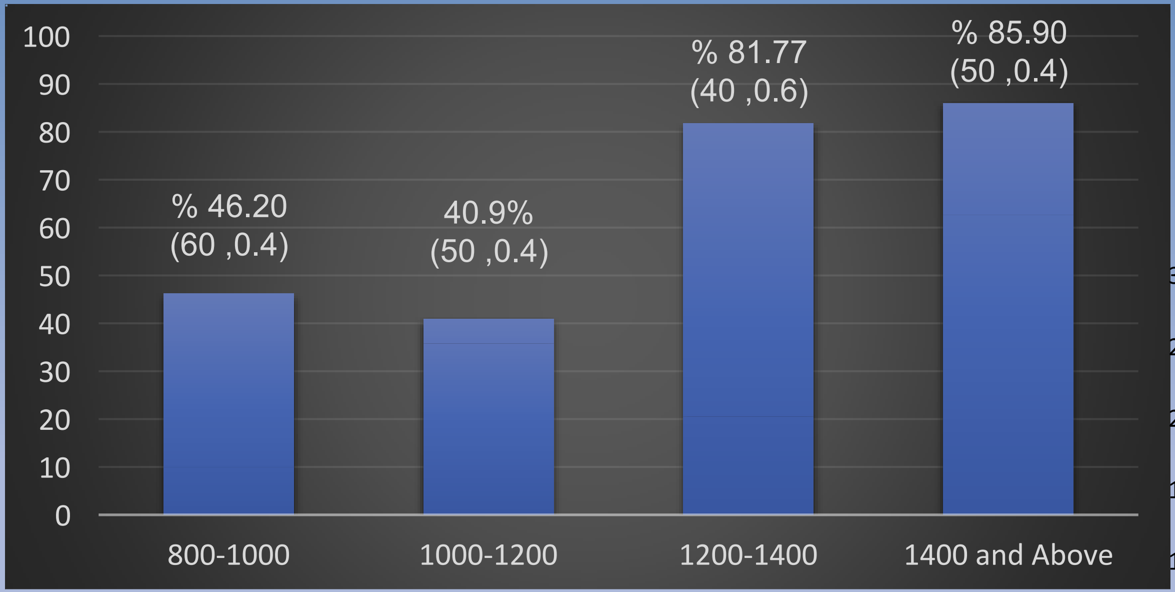
Struvite, 2.7
Mixed, 2.7
Uric Acid, 18.2
(UA)
Calcium Oxalate Monohydrate, 42.7
(COM)
Calcium oxalate Dihydrate, 33.7
(COD)
Stone Composition (%)

Stone Composition : COM

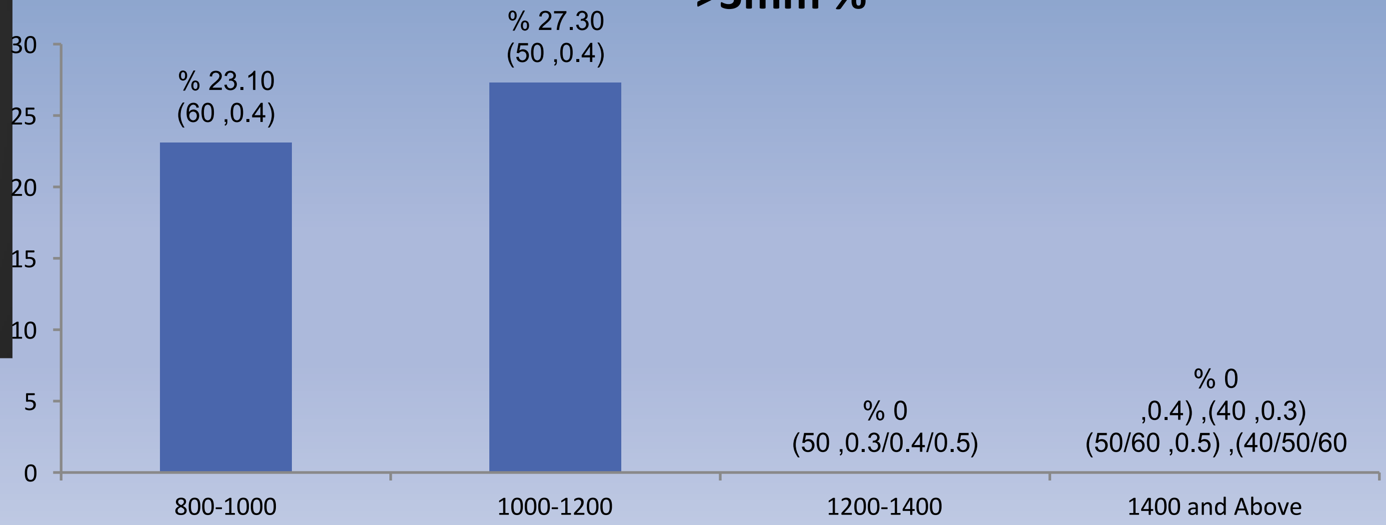
1-3mm %



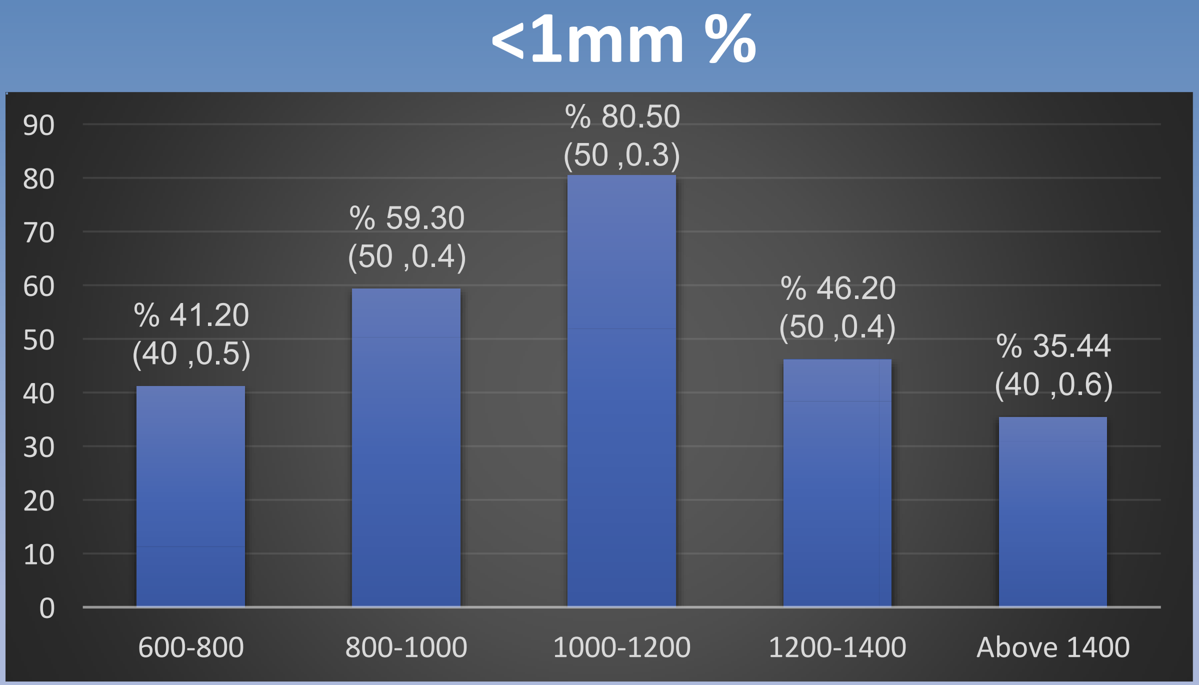
<1mm %

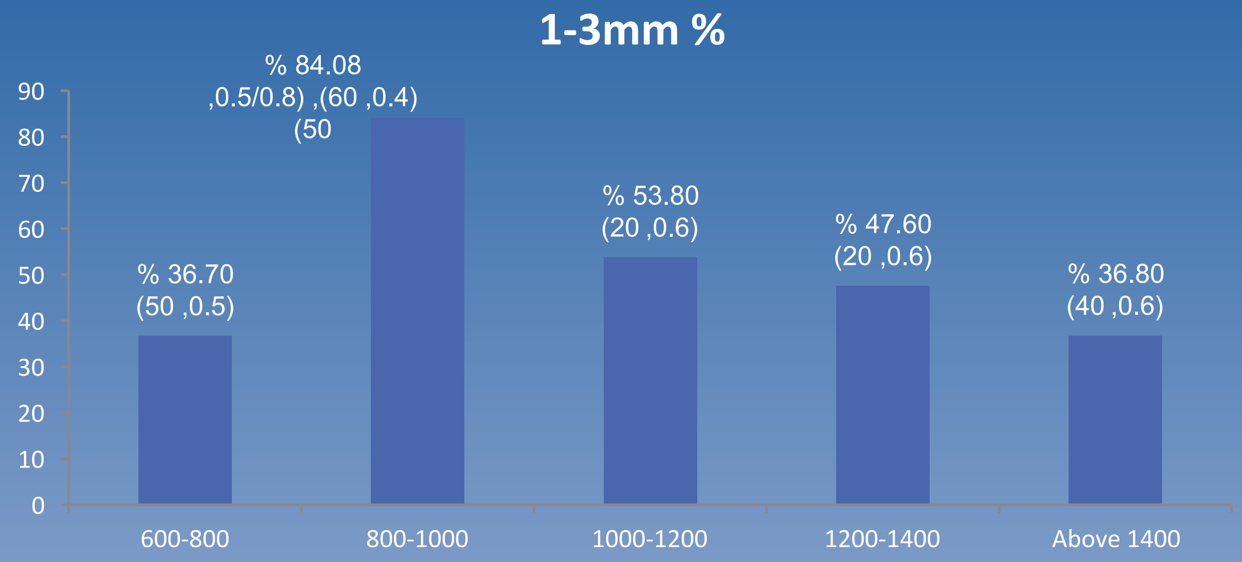


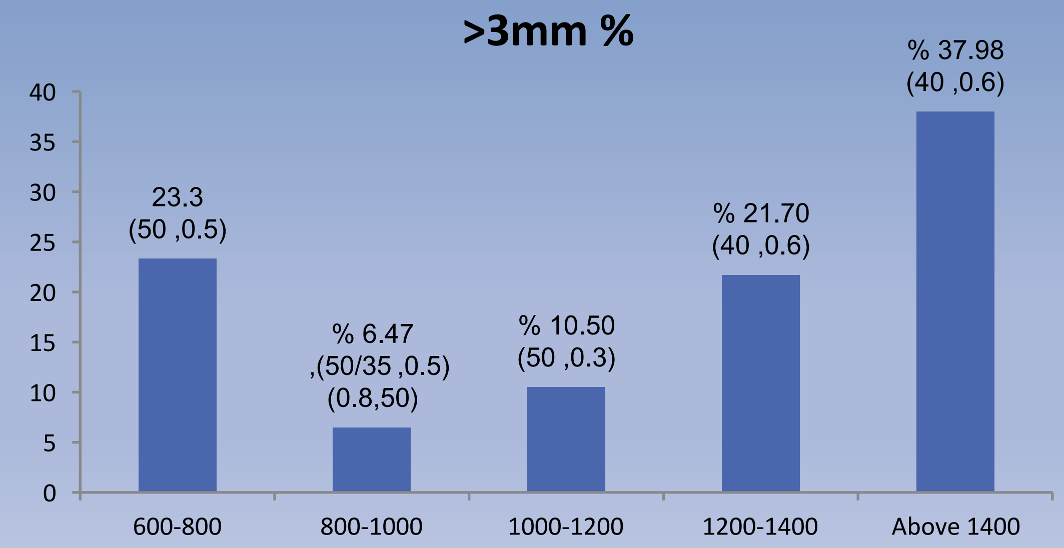
>3mm %



Stone Composition : COD







Optimal laser settings [Pulse energy(PE) in Joules, Pulse frequency (PF) in Hz] for maximum dusting for each stone composition and stone density.

Density (HU)	Overall		Calcium oxalate dihydrate		Calcium oxalate monohydrate		Mixed composition		Struvite		Uric Acid	
	Laser Setting (PE, PF)	% Max Dust	Laser Setting (PE, PF)	%Max Dust	Laser Setting (PE, PF)	% Max Dust	Laser Setting (PE, PF)	% Max Dust	Laser Setting (PE, PF)	% Max Dust	Laser Setting (PE, PF)	%Max Dust
<1000	(0.4, 50)	75	(0.4, 50)	59.3	(0.4, 60)	46.2	(0.5, 40)	47.1	(0.4, 40)	61.9	(0.4, 50)	75
1000-1400	(0.6, 30)	81.7	(0.3, 50)	80.5	(0.6, 30)	81.77	(0.4, 50)	68.4	(0.4, 40)	50	(0.3, 40)	64.4
>1400	(0.4, 50)	85.9	(0.6, 40)	35.4	(0.4, 50)	85.9	(0.6, 40)	78.2	(0.3, 40)	39.4	(0.5, 40)	60

Optimum energy settings

Stone Composition	Energy Setting (J, Hz)	Max Dust %
COD	(0.3, 50)	80.5
COM	(0.4, 50)	85.9
Mixed	(0.5, 50)	54.5
Struvite	(0.4, 40)	61.9
UA	(0.4, 50)	75

Stone Density (HU)	Energy Setting (J, Hz)	Max Dust %	Consistent energy setting giving maximum dust was Setting in and around
< 1000	(0.4, 50)	75	(0.4,50)
1000-1400	(0.6, 30)	81.7	(0.4,50)
>1400	(0.4, 50)	85.9	(0.4,50)

We found that ***0.4J - 0.5 J and 40-50 Hz*** was the preferred initial laser setting that may need to be modified based on the individual stone.

With these settings, around 75% of the stone volume can be dusted into a size that could be simultaneously aspirated in the space between the nephroscope and sheath, while **25% would require aspiration through the main sheat**h by withdrawing the scope beyond the suction port.

CONCLUSION

- Despite varying laser energy settings, across various stone compositions, the majority of fragments created are either < 1mm or 1-3 mm that are difficult to basket, whilst easier to aspirate. Only 25% fragments were >3 mm that would likely be basketed easily.
- These findings suggest that basketing techniques alone may be insufficient to achieve complete stone clearance and may influence stone extraction strategies going forward.
- Formation of maximum dust and addition of suction to the sheath will aid in maximum stone clearance.

EVERY LIFE DESERVES WORLD CLASS CARE

THANK YOU