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RESEARCH

Vacuum-assisted renal sheath clears 1 cm^3 of stone faster than non-suction sheath in mini-percutaneous nephrolithotomy

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Abstract

Objectives To address the literature paucity regarding the surgical outcomes with the utilization of vacuum-assisted renal access sheath (VA-RAS) versus usual miniaturized renal access sheath (RAS) in mini-percutaneous nephrolithotomy (mini-PCNL).

Materials and methods Retrospective cohort data for patients who underwent supine mini-PCNL with the HoYAG laser platform (Lumenis Pulse P120H™, 120 W, Boston Scientific®) between 08/2021 and 07/2024. Exclusion criteria included patients with urinary diversion, cases using any other form of stone fragmentation but laser, and those with ureteral stones. VA-RAS (ClearPetra™, MicroTech Endoscopy®, China) and RAS (MIP-M, Karl Storz®, Germany) were compared. Stone-free rate (SFR) was assessed by CT scan performed on the first postoperative day and presented as: absence of stone fragments, no fragments larger than 2 mm, or no fragments larger than 4 mm.

Results A total of 111 patients met the study criteria, of which VA-RAS was used for 57 patients (51.4%). Despite higher stone volume in VA-RAS group, there was no difference in total operative time. Nevertheless, laser ablation efficiency and time to clear 1 cm^3 was lower in VA-RAS group. Overall, there was no difference in SFR between VA-RAS and RAS (no fragments: RR 1.3, CI 95% 0.9–1.8, $p = 0.11$; fragments < 2 mm: RR 1.1, CI 95% 0.8–1.4, $p = 0.68$; fragments < 4 mm: RR 1.2, CI 95% 0.9–1.5, $p = 0.09$).

Conclusion We observed an equivalent postoperative SFR, total operative time and laser ablation speed when comparing VA-RAS and RAS in mini-PCNL. However, we observed a higher laser ablation efficiency and lower time clear 1 cm^3 of stone with VA-RAS group.

Keywords Vacuum-assisted access sheath · ClearPetra · Mini-PCNL · Minimally invasive percutaneous nephrolithotripsy · Urolithiasis

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Introduction

Percutaneous nephrolithotomy (PCNL) is the recommended treatment for renal calculi larger than 20 mm according to the American Urological Association (AUA) guidelines [1]. Nevertheless, PCNL has been associated with various adverse events, such as pneumothorax, postoperative fever, sepsis, bleeding, and the need for blood transfusion. One response to these complications was the development of smaller renal access sheaths (RAS), which were first introduced in 2001[2].

Miniaturized PCNL (mini-PCNL) reduced the diameter of the typical 24–30 Fr regular PCNL sheath to 14–22 Fr. This shift was responsible for reducing postoperative pain and bleeding complications while maintaining similar stone-free rates (SFR) to PCNL for 10–30 mm renal stones [3]. However, miniaturization limits irrigation inflow, reduces outflow, and requires a higher degree of fragmentation of stones to allow for removal through the smaller sheath lumen. The result is a procedure that may be associated with longer operative time, increased intrarenal pressure, decreased visibility, and potentially more demanding stone retrieval [3].

The ClearPetra™(MicroTech Endoscopy®, China) vacuum-assisted renal access sheath (VA-RAS) is a novel technology that allows for concomitant irrigation and suction during the mini-PCNL [4]. This VA-RAS is available in sizes from 10/12 Fr up to 24/26 Fr and consists of a standalone single-use plastic sheath with an oblique side channel that is connected to suction, situated at 45° to the sheath axis as well as an inner obturator for the dilation step of the procedure. The suction tubing connected to the percutaneous sheath attaches to a separate stone collection bottle to allow for retrieval of stones for analysis or culture. This sheath allows for continuous dusting and extraction, as smaller fragments are aspirated passively through the area between the scope and the inner aspect of the VA-RAS.

Although there have been studies comparing the VA-RAS against RAS in mini-PCNL [5–10] and its variant miniaturized endoscopic combined intrarenal surgery (mini-ECIRS) [11], papers investigating an American population are severely lacking. Also, some did not evaluate the effect of high-powered laser with pulse modulations supine position [1, 7, 9]. Likewise, others restricted their analysis to only staghorn calculi [8, 10]. This study addresses the literature paucity regarding the outcomes when utilizing VA-RAS vs. RAS in mini-PCNL. We hypothesized that the VA-RAS may provide more efficient stone clearance, secondary to its ability to allow continuous suction during laser lithotripsy.

Materials and methods

Study design and patient selection

A retrospective chart review was completed for patients aged ≥ 18 years of age undergoing supine mini-PCNL for the treatment of nephrolithiasis at the University of Kansas Medical Center from August 2021 to July 2024, regardless of stone size or complexity. Renal stones were diagnosed by preoperative non-contrast computed tomography (CT). Exclusion criteria included patients with urinary diversion (i.e., ileal conduit or neobladder), simultaneous utilization of > 1 laser platform, cases using any other form of fragmentation (ex: electromagnetic impact or ultrasonic energy), and patients with ureteral stones or concurrent bilateral stone procedures.

Technique

Patients were grouped according to which access sheath was used during mini-PCNL. The equipment was assigned according to surgeon's discretion and sheath availability on the day of surgery. VA-RAS (ClearPetra™, MicroTech Endoscopy®, China) and RAS (MIP-M, Karl Storz®, Germany) were compared. Surgery was performed by three experienced fellowship trained surgeons with the patient under general anesthesia, in the modified supine position with slight lateralization with a flank bump, and on a split leg bed to give access to both the kidney for mini-PCNL and the genital region for the mini-endoscopic combined aspect of the case (use of concurrent, ipsilateral retrograde flexible ureteroscopy (URS)). Prior to positioning, the posterior axially line was marked to ensure safe access needle placement.

Percutaneous access was obtained via fluoroscopy guidance in all cases using a triangulation technique, with the c-arm alternating between 0 degrees and 15 to 30 degrees toward the head. VA-RAS group utilized a 16/18 Fr sheath. The RAS group utilized the MIP-M Miniperc instrument with the 15/16 Fr dilatation system. Nephrolithotripsy was then completed in either group using a 12 Fr mini-nephroscope (model 27830KA from MIP-M set, Karl Storz®) equipped with high power Holmium: yttrium-aluminium-garnet (HoYAG) laser with MOSES technology (Lumenis Pulse P120H™, 120 W, Boston Scientific®). Start-up HoYAG laser settings were 1.5 J and 20 Hz, with MOSES distance mode. Further laser setting adjustments could be made according to the surgeon's discretion. Irrigation is provided via the working channel of the nephroscope and outflow is regulated by the suction control on the stone collection bottle. After most of the stone was fragmented and all visible fragments were cleared through the vortex effect or suction, a flexible ureteroscope (FLEX-XC, Karl Storz®) was inserted through the urethra to navigate in a retrograde fashion and finish clearing all remaining calyces in a mini-endoscopic combined approach. Remaining stone fragments were manipulated out with retrograde ureteroscopic irrigation, basketing, or lasering. If lasering was required via the ureteroscope, the same laser fiber and platform utilized for the PCNL portion of the procedure were used. A final navigation was completed with assistance of fluoroscopic images for evaluation of any remaining visible fragments. A double J stent was placed vs. a nephrostomy tube at the conclusion of the procedure, per the surgeon's discretion.

Data management

Demographic information was gathered from the patient's chart, as well as stone characteristics derived from their pre and postoperative CT-scan. Stone burden was reported as cumulative total stone volume using elliptical equation of volume (cm [3]) (4/3 * π * length * width * height). Stone size is reported as the single largest stone diameter measured in mm.

Perioperative information assessed included the presence of preoperative nephrostomy tube or stent. The equipment used during the procedure was also evaluated, such as ureteral access sheath diameter (if used), laser fiber size, total laser time and energy, total operative time, postoperative stent and/or nephrostomy tube placement. Total operative time was calculated from surgical time-out to procedure finish, according to the intraoperative record. From these variables, laser ablation efficiency was determined by dividing total laser energy utilized by stone volume. Laser ablation speed was determined by dividing stone volume by total laser time. Time to clear 1 cm^3 was calculated by dividing stone volume by total operative time.

Finally, postoperative results were evaluated by assessing hospital length of stay in days and SFR. The latter was determined by a non-contrast CT-scan performed within first 24 h after surgery. Because of the lack of consensus defining true SFR, we report SFR in terms of absence of stone fragments, no fragments larger than 2 mm, or no fragments larger than 4 mm. Intraoperative blood loss was estimated comparing the difference between pre-surgery and post-operative day #1 hemoglobin and hematocrit. Furthermore, changes in glomerular filtration rate (GFR) were also reported in the same manner. GFR was estimated using creatine clearance according to Cockcroft-Gault formula: (140– Age) * Mass (kg) * (0.85 if female)/ 72 * [Serum Creatinine (mg/dL)].

The main objective of this study was to compare SFR among both access sheaths. Secondary objectives were residual stone volume, as well as time to clear 1 cm^3. We also assessed hospital length of stay, intraoperative bleeding, and changes in GFR.

Data storage and statistical analysis

After obtaining ethics approval and waiver of consent, all patient data were collected and stored in a REDcap database. Categorical variables were compared using chi-square test or Fisher's exact test for small cell sizes. Continuous variables were compared using a two-tailed t-test. The relative risk for SFR was calculated considering VA-RAS as exposure to see if there was an association between the suction and SFR. ANCOVA model was conducted for multivariate analysis of total operative time when adjusting for stone volume, Hounsfield units and Guy score. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software (version 23.0, Armonk, NY: IBM Corp) and R (version 4.2.3). A p-value ≤ 0.05 was considered statistically significant.

Results

Demographics and preoperative characteristics

Between August 2021– July 2024, 111 patients underwent mini-PCNL at our institution and were eligible for inclusion in the study. A total of eight patients were excluded, five due to presence of a urinary diversion and three due to concurrent ureteral stones. Of all patients selected, 51.4% underwent mini-PCNL with VA-RAS and 48.6% with RAS. Table 1 includes baseline patient demographics and stone characteristics, with no significant differences between the two study groups, except for higher stone volume and density in VA-RAS group.

Intra-and postoperative characteristics

Intraoperative data for the two groups are presented in Table 2. Total operative time was similar in both groups, but VAS-RAS use was associated with better ablation efficiency (3.2 kJ/cm^3 vs. 4.8 kJ/cm^3, $p=0.04$) and shorter time to clear 1 cm^3 (22.1 min vs. 32.1 min, $p=0.01$) of stone. When adjusting for stone volume, Hounsfield units and Guy Score, multivariate analysis on total operative time comparing VA-RAS and RAS was not significantly different ($p=0.89$). Additionally, we did not observe any significant differences in total laser time, energy, or ablation speed. There was no difference between groups for utilization of ureteral stent vs. nephrostomy tube or intraoperative ureteral injury.

Overall, 73.8% of patients were stone free after mini-PCNL, with no fragments larger than 4 mm on CT scan

Table 1 Patient demographics and stone characteristics

	VA-RAS ($n=57$)	RAS ($n=54$)	p-value
Age (years), median (IQR)	62 (46–72)	64.0 (50.3–69.8)	0.82
Gender, n (%)			
Male	23 (40.4)	28 (51.9)	0.31
Female	34 (59.6)	26 (48.1)	
Race, n (%)			
White	52 (91.2)	49 (90.7)	0.63
African American	1 (2.4)	3 (5.6)	
Latin American	3 (5.3)	2 (3.7)	
Asian	1 (2.4)	0	
Body mass index, median (IQR)	29.9 (23.4–37.1)	29.1 (24.7–34.2)	0.77
ASA, median (IQR)	3 (2–3)	3 (2–3)	0.25
Preoperative stent, n (%)	12 (21.1)	6 (11.1)	0.25
Preoperative nephrostomy, n (%)	6 (10.7)	9 (17.0)	0.50
Laterality, n (%)			
Right	26 (45.6)	20 (38.5)	0.57
Left	31 (54.4)	32 (61.5)	
Number of stones, median (IQR)	2 (1–3)	2 (1–3.8)	0.14
Stone Complexity*, n (%)			
1	18 (31.6)	14 (25.9)	0.21
2	16 (28.1)	17 (31.5)	
3	19 (33.3)	23 (42.6)	
4	4 (7.0)	0	
Stone size (mm), median (IQR)	25.0 (18.9–39.3)	26.3 (17.7–42.7)	0.74
Stone volume (cm^3), median (IQR)	3.1 (1.4–8.4)	2.0 (1.0–4.2)	0.02
Stone density (HU), median (IQR)	1209 (1021–1393)	1046.5 (699.9–1311.8)	0.04

VA-RAS: Vacuum-assisted renal access sheath

RAS: Usual renal access sheath

IQR: Interquartile range

ASA: American Society of Anesthesiologists score

HU: Hounsfield units

* Based on Guy's stone score

Table 2 Perioperative data

	VA-RAS ($n=57$)	RAS ($n=54$)	p-value
Ureteral access sheath, n (%)			
Not utilized	51 (89.5)	48 (8.9)	0.41
11/13 Fr, 36 cm	4 (7.0)	6 (11.1)	
12/14 Fr, 36 cm	2 (3.5)	0	
Flexible Ureteroscope usage, n (%)			
Basketing, flushing	41 (72.0)	42 (77.8)	0.62
Lasering	16 (38.0)	12 (22.2)	
Fiber Size, n (%)			
200 µm	6 (11.3)	0	0.00
365 µm	45 (84.9)	35 (64.8)	
550 µm	2 (3.8)	19 (35.2)	
Total laser time (min), median (IQR)	540 (240–1068.3)	390 (180–750)	0.12
Total laser energy (kJ), median (IQR)	12.1 (5.7–25.7)	9 (4.3–22.9)	0.33
Total operative time (min), median (IQR)	78 (57.0–107.0)	65.5 (54.3–101.3)	0.43
Laser ablation efficiency (kJ/cm^3), median (IQR)	3.2 (1.6–6.0)	4.8 (2.5–8.8)	0.04
Laser ablation speed (mm^3/sec), median (IQR)	7.3 (3.9–15.7)	5.3 (3.2–10.4)	0.06
Time to clear 1cm^3 (min/cm^3), median (IQR)	22.1 (11.2–44.3)	32.1 (19.5–55.7)	0.01
Postoperative stent, n (%)	54 (94.7)	48 (88.9)	0.31
Postoperative nephrostomy, n (%)	7 (12.3)	7 (13.2)	1.00
Ureteral injury, n (%)			
None	57 (100)	52 (96.3)	
Grade I	0	2 (3.7)	

VA-RAS: Vacuum-assisted renal access sheath

RAS: Usual renal access sheath

IQR: Interquartile range

obtained on postoperative day number 1. Table 3 evaluates SFR results for both sheaths, showing that there were no statistical differences between VA-RAS and RAS, regardless of how SFR is evaluated (no fragments, no fragments > 2 mm, or no fragments > 4 mm; p values = 0.16, 0.68, and 0.14, respectively). Relative risk also remained non-significant with confidence interval including 1 in all categories. This variable was further investigated by stratifying according to Guy Score, where VA-RAS was associated with higher SFR in Guy Score group 1 when considering no fragments larger than 4 mm, with $p=0.03$.

Finally, Table 3 also contains the postoperative data, which demonstrated no difference in procedural blood loss between either access sheaths, with similar changes in hemoglobin and hematocrit between groups. There was no need for blood transfusions in any of the 111 cases. Likewise, no difference in GFR was observed. Median hospital stay of 1 day was obtained in both groups. No patients presented fever or sepsis after the procedure up to discharge in both groups.

Discussion

This study is currently the first retrospective comparison between VA-RAS and RAS in an American patient population in mini-PCNL and its variant, mini-ECIRS. Although we did not observe any difference in SFR, we observed shorter time to clear 1 cm^3 of stone in the VA-RAS group when compared to RAS (23.2 cm^3/min vs. 32.1 cm^3/min, respectively, $p=0.02$ and higher efficiency when using VA-RAS as surgeons used less time to clear the same stone

Table 3 Postoperative results

	VA-RAS ($n=57$)	RAS ($n=54$)	p-value
No stone fragments, n (%)	38 (66.7)	28 (51.9)	0.16
◊ RR VA-RAS vs. RAS (CI 95%)	1.19 (0.84–1.69)		0.32
No stone fragments > 2 mm, n (%)	38 (66.7)	33 (61.1)	0.68
◊ RR VA-RAS vs. RAS (CI 95%)	1.1 (0.8–1.4)		0.54
No stone fragments > 4 mm, n (%)	46 (80.7)	36 (66.7)	0.14
◊ RR VA-RAS vs. RAS (CI 95%)	1.2 (0.9–1.5)		0.09
Stone Free Rates when controlling for Guy Score			
	No stone fragments		
Guy Score	**VA-RAS**	**RAS**	**p value**
1	16 (88.9%)	9 (64.3%)	0.1
2	12 (75%)	9 (52.9%)	0.19
3	9 (47.4%)	10 (43.5%)	0.8
4	1 (25%)	None	***
Overall	38 (66.7%)	28 (51.9%)	0.16
	No stone fragments > 2 mm		
Guy Score	**VA-RAS**	**RAS**	**p value**
1	16 (88.9%)	9 (64.3%)	0.1
2	12 (75%)	12 (70.6%)	0.78
3	9 (47.4%)	12 (52.2%)	0.76
4	1 (25%)	none	***
Overall	38 (66.7%)	33 (61.7%)	0.68
	No stone fragments > 4 mm		
Guy Score	**VA-RAS**	**RAS**	**p value**
1	17 (94.4%)	9 (64.3%)	0.03
2	14 (87.5%)	14 (82.4%)	0.69
3	12 (63.2%)	13 (56.5%)	0.66
4	3 (75%)	none	***
Overall	46 (80.7%)	36 (66.7%)	0.14
Residual stones characteristics			
Stone size (mm)*, median (IQR)	4.9 (3.6–7.5)	20 (2.6–38)	0.10
Type of stone, n (%)			
Calcium oxalate monohydrate	7 (17.1)	19 (35.8)	0.04
Calcium oxalate dihydrate	1 (2.4)	2 (3.8)	
Calcium phoshate, apatite	3 (7.3)	3 (5.7)	
Calcium phosphate, brushite	0	0	
Calcium mixed	25 (61.0)	17 (32.1)	
Uric acid	4 (9.8)	7 (13.2)	
Struvite	1 (2.4)	4 (7.5)	
Cystine	0	1 (1.9)	
Blood loss and change in GRF			
Hospital-stay length (days), median (IQR)	1 (1–1)	1 (1–1)	0.95
Δ Hgb (g/dL)**, median (IQR)	-1.0 [-1.8– (-0.2)]	-1.2 [-1.7– (-0.8)]	0.44
Δ Hct (%)**, median (IQR)	-3.4 [-5.6– (-0.8)]	-3.2 [-5.2– (-2.1)]	0.82
Δ GFR (mL/min)**, median (IQR)	-0.9 (-8.1–9.3)	0.9 (-5.3–8.4)	0.52

VA-RAS: Vacuum-assisted renal access sheath

RAS: Usual renal access sheath

IQR: Interquartile range

RR: Relative risk

Hbg: Hemoglobin

Hct: Hematocrit

GFR: Glomerular filtration rate

* Based on CT-scan performed on first postoperative day

** Based on laboratory workup done on first postoperative day volume during mini-PCNL. Our study did not show that suction improves laser ablation speeds when using HoYAG laser with MOSES technology; however, this is not surprising considering the laser platform utilized is the same in both groups and just the stone fragment clearance mechanism is different. We found no studies in the literature that investigated these laser-related variables for comparison. However, an RCT on the treatment of 2–4 cm stones employing HoYAG laser in prone mini-PCNL showed higher stone extraction rate with suction sheaths (166.4 mm^3/min vs. 90.4 mm^3/min, $p<0.001$)[5]. This finding may suggest that suction plays a more significant part in stone extraction when in the prone position than the supine position, but more focused prospective studies are needed to back this claim and specifically evaluate the amount of time that is spent clearing the stone during and after stone fragmentation. It is important to note that in our study that all stones could be extracted by suction alone in 4 of the 57 cases completed with VA-RAS.

It is essential to highlight how stone extraction is completed with both sheaths, which may help us understand the differences in stone clearance efficiency noted between the two groups in our study. During mini-PCNL, when a standard RAS is employed, most stone fragments are removed by the vacuum-cleaner effect, also known as the vortex effect [12]. This is a hydrodynamic phenomenon that has been relatively understudied [13]. Ito et al. developed a physical model explaining this effect as a pressure gradient created between the collecting system and a fluid recirculation area located at the nephroscope tip. This difference in pressure is the driving force that bends the fluid creating an outflow fluid column through the sheath together with the stones [14].

Alternatively, VA-RAS provides active suction through the sheath itself. This allows for continuous evacuation of smaller stone fragments and dust around the scope while performing lithotripsy, without the need to stop lasering. Larger fragments are removed by retracting the scope towards the bifurcation of the sheath, where the suction arm then evacuates the stone out of the sheath [4]. This combination may better explain why surgeons cleared the same stone volume in less time when employing VA-RAS.

Both groups presented with similar demographics and stone characteristics, except for stone volume (3.1 cm^3 vs. 2.0 cm [3], $p=0.01$) and density (1209.0 HU vs. 1046.5 HU, $p=0.04$), which was higher in the VA-RAS group. To normalize the analysis and address this factor, the authors decided to use time to clear 1 cm^3 instead of total operative time. The superiority of VA-RAS in saving operating room time may be inferred when there is a higher laser ablation efficiency and a shorter time to clear 1 cm^3, even if maintaining similar total operative time in this scenario. In other words, the fact that VA-RAS achieves similar operative times for a population with higher stone burden is suggestive of its higher efficiency. These findings echo prior studies that showed reduced total operative time when using VA-RAS in mini-PCNL [7, 10]. A meta-analysis of four randomized controlled trials (RCT) and three retrospective studies involving 1803 patients reported that total operative time was significantly shorter [SMD = -0.84. 95% CI (-1.20, -0.48). $p<0.001$][15]. These variables may be better studied in a prospective fashion, where the time required for obtaining percutaneous access vs. time for stone lasering vs. time for active stone extraction can each be individually and accurately measured.

Our study found no statistical difference in SFR when comparing both sheaths in mini-PCNL. A similar finding was reported by an RCT comparing VA-RAS to conventional sheaths in supine mini-PCNL at 3 months [6]. However, most papers in literature favor VA-RAS reporting higher SFR when compared to RAS in mini-PCNL. Liang et al. conducted an RCT where they found higher SFR when using suction sheaths at 3 days, but not at 30 days postoperatively [5]. Additionally, the previously mentioned meta-analysis reported that both immediate and final odds for SFR were significantly higher in VA-RAS group [OR = 1.69, 95% CI (1.30, 2.18), $p<0.001$; OR = 1.44. 95% CI (0.98, 2.13), $p=0.039$][15]. In treating staghorn calculi, literature also shows higher SFR with VA-RAS (78.5% vs. 69.1%; $p=0.016$) compared to traditional mini-PCNL [16].

Of note, our absolute stone free rate was slightly lower than that commonly reported in the literature in supine mini-PCNL [5, 9, 15, 17]. Most studies determine “final” SFR by performing post-op CT scans within 30 days of procedure. On the other hand, our study committed to first-day postoperative CT scan, due to our clinic’s workflow. Since we did not evaluate postoperative clinic encounters, we cannot account for patients who could have potentially eliminated smaller fragments and would have become stone-free within the first 30- or 90-days post-surgery.

Finally, this study shows no significant distinction in peri-operative bleeding, change in renal function, or hospital stay length between both sheath groups. This finding echoes another RCT that compared both sheaths in prone mini-PCNL, where no difference was found [5]. The aforementioned meta-analysis supports this finding by showing no change in hemoglobin drop or hospital stay between the groups [15]. The VA-RAS appears to be equally as safe as the traditional RAS.

The current study has a few limitations. First, it is a retrospective, observational, and single-center study. With regards to aspects of quality of life, patient-reported outcome measures were not evaluated as postoperative clinic encounters were outside the scope of this study [18, 19]. The selection of which sheath would be used during the procedure was according to the surgeon's discretion and availability on the day of surgery. It is important to emphasize that all data were gathered from the electronic medical record (EMR), intraoperative report, and imaging system exclusively by authors without any industry relationships. The total operative time was obtained from the EMR, from which we could not differentiate between time spent obtaining percutaneous renal access vs. operative time spent treating the stone itself. Likewise, changes in laser setting were not recorded and could be a confounding factor that cannot be evaluated. Finally, VA-RAS access sheath has a slightly larger diameter (16/18 Fr) when compared to RAS (15/16 Fr), which may allow for faster drainage of fragments and not associated to the benefit of suction alone.

Additionally, the importance of future prospective trials comparing both sheaths cannot be overstated. There is currently an ongoing RCT (NCT05993546) by Cleveland Clinic in recruiting phase [20]. We excitedly anticipate the results of this trial as it will help to address some of our currently unanswered questions on the utility and utilization of suction in mini-PCNL.

Conclusions

Both VA-RAS and standard RAS are excellent choices for mini-PCNL with comparable SFR and complication rates. This study highlights higher laser ablation efficiency and a shorter time to clear 1cm^3/min of stone with a suction sheath compared to standard non-suction renal access sheath. Additional studies are needed for further insight, such as a prospective RCT comparing VA-RAS and RAS in mini-PCNL.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethical approval This is study was conducted in accordance with ethical standards. IRB approval was obtained prior to the beginning of this study, IRB# STUDY00160203, which waivered the need for HIPAA authorization.

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