Original Article

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Assessing Stone Clearance in Non-Prestented Patients Undergoing Retrograde Intrarenal Surgery with a 9.5 Fr Re-access Ureteric Sheath: A Single-Center Study

Assad ur Rehman[1], Nadeem Bin Nusrat[1], Shujah Muhammad[1], Nauman Zafar[1], Asadullah Aslam[1], Sarmad Imtiaz[1], Ammar Asghar[1], Abdul Hanan[1], Saira Imtiaz[2*]

[1] *Department of Urology, Pakistan Kidney and Liver Institute and Research Centre Lahore, Pakistan*
[2] *Department of Research, Pakistan Kidney and Liver Institute and Research Centre Lahore, Pakistan*

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Corresponding Author
Saira Imtiaz
Department of Research,
Pakistan Kidney and Liver Institute and Research Centre,
Lahore- Pakistan.
Email: saira.khan@pkli.org.pk
ORCID: 0000-0003-1197-7565

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Abstract

Objective: To assess stone clearance and perioperative outcomes in non-prestented patients undergoing RIRS using a 9.5 Fr re-access ureteral sheath and to identify clinical and procedural characteristics associated with complete versus partial stone clearance.

Methodology: This retrospective observational analytic cohort study was conducted at the Pakistan Kidney and Liver Institute and Research Centre, Lahore from September 2018 to August 2023. A total of 179 non-prestented patients who underwent RIRS using a 9.5 Fr re-access ureteric sheath were included. Stone clearance was assessed using postoperative non-contrast computed tomography (CT) and categorized as complete or partial according to the predefined residual-fragment criteria. Baseline, clinical, operative, and postoperative characteristics were compared between patients with complete and partial stone clearance to identify factors associated with clearance status. Continuous variables were analyzed using the independent-samples t-test or Mann–Whitney U test, as appropriate, while categorical variables were compared using the chi-square or Fisher's exact test.

Results: Complete stone clearance was achieved in 150 patients (83.8%), whereas 29 patients (16.2%) had partial clearance. Patients with partial clearance had significantly larger stones than those with complete clearance (median 1.65 vs. 1.10 cm, $p<0.001$) and higher preoperative white blood cell counts ($p=0.011$). Residual fragments on postoperative imaging and the need for additional procedures were significantly more frequent among patients with partial clearance ($p<0.001$ for both). Partial clearance was also associated with longer hospital stay ($p=0.043$), larger residual fragment size ($p<0.001$), and delayed DJ stent ($p<0.001$) and Foley catheter removal ($p=0.006$). Operative and laser times did not differ significantly between the groups (both $p>0.05$).

Conclusion: RIRS with a 9.5 Fr re-access ureteric sheath achieved high stone clearance in non-prestented patients. Larger stones were more likely to result in partial clearance. This suggests the sheath can allow RIRS without routine pre-stenting in selected cases, though comparative studies with prestented cohorts are needed to clarify the role of preoperative stenting.

Keywords: surgical outcomes, retrograde intrarenal surgery (RIRS), ureteral access sheath, kidney stones, preoperative ureteral stenting, stone clearance, non-prestented patients

Introduction

The benefits of using a ureteral access sheath (UAS) in RIRS are well established. These benefits include reduced operative time, better and repeat access to the ureter, active stone fragment clearance, lower intrapelvic pressure during RIRS, and avoidance of intermittent bladder catheterization.[1-5] Conversely, the potential complications of using a UAS are the potential for ureteral injury and postoperative pain if a ureteral stent is not inserted post-procedure.[6,7] Preoperative ureteric stenting is mainly used for internal drainage in the case of obstructive renal stone calculi, hydronephrosis, or urinary tract infection. It is also employed for passive dilation of the ureter to provide easy endoscopic entry.[8,9] The potential complications of ureteral stenting are infection, encrustations, hematuria, and irritation of the tissue, among others. Some previous research studies have indicated a better stone-free rate (SFR) after ureteroscopic lithotripsy in the event of pre-procedure ureteric stenting. Nonetheless, the effectiveness of routine ureteral stenting in modern-day urology remains controversial.[10,11] Although the advantages and complications of ureteral stenting are well recognized, evidence regarding RIRS outcomes in non-prestented patients using smaller-caliber (9.5 Fr) re-access ureteric sheaths remains limited. Previous studies have either included mixed patient cohorts or evaluated higher-caliber sheaths; therefore, the feasibility of performing RIRS without routine preoperative stenting when using a small-caliber UAS remains uncertain. Evaluating stone clearance in non-prestented patients undergoing RIRS with a 9.5 Fr re-access ureteric sheath is therefore clinically relevant for assessing whether effective stone clearance can be achieved without routine preoperative ureteric stenting.

Thus, the objective of the current study was to assess stone clearance and perioperative outcomes in non-prestented patients undergoing RIRS using a 9.5 Fr re-access ureteric sheath at the Pakistan Kidney and Liver Institute & Research Center, Lahore, Pakistan, and to identify clinical and procedural characteristics associated with complete versus partial stone clearance.

Methodology

This is a retrospective observational analytic cohort study carried out at the Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan. The study got approval from the Institutional Review Board with the approval number PKLI-IRB/AP/162 on 20 November 2023. Data were retrospectively extracted from medical records of patients who underwent RIRS between 3 September 2018 and 28 August 2023. As this was a retrospective study involving existing medical records, the requirement for written informed consent was waived by the Institutional Review Board.

In total, the study involved 179 patients undergoing retrograde intrarenal surgery (RIRS) without stenting pre-operatively using a 9.5 Fr re-access ureteric sheath. The criteria for patient inclusion were:

- Patients without a preoperative ureteral stent.
- Procedures utilizing the 9.5 Fr re-access ureteric sheath.
- Availability of comprehensive medical records (pre-, intra-, and postoperative data).

Exclusion criteria included:

- Patients with a preoperative DJ stent in situ were excluded from analysis.
- Emergency RIRS cases.

Consecutive sampling was used to ensure representativeness. This study collected data through patient medical records. A structured form for gathering data was used. This helped to record details about patient demographics, clinical features, and other details.

The RIRS procedure was done under general anesthesia. A disposable OTU trademark flexible ureteroscope was passed through a 9.5 Fr re-access ureteric sheath in order to navigate within the renal collecting system. Quanta 30 Watt laser lithotripsy was employed for stone fragmentation. All surgeons followed the same laser energy settings and fragmentation protocol to minimize procedural variability.

Fluoroscopy and retrograde pyelography were utilized intraoperatively for anatomical visualization and stone localization. The following procedural steps were documented:

1. Initial plain fluoroscopic imaging visualized the angled flexible ureteroscope reaching the lower pole stone (Figure 1A).
2. Additional images confirmed the approach and location of the stone (Figures 1B and 1C).
3. Retrograde pyelography outlined renal anatomy and stone position (Figures 1D and 1E).
4. Endoscopic views visualized laser lithotripsy targeting the stone (Figure 1F).

Irrigation fluid was used to clear fragments, and fluoroscopic and endoscopic views were employed to assess stone clearance intraoperatively. Postoperative stone-free status was assessed using non-contrast CT scans. Complete clearance was defined as no residual fragments (0 mm), while partial clearance was defined as residual fragments <2 mm, while fragments <2 mm are often considered clinically insignificant, we categorized them as 'partial clearance' to maintain a strict and objective definition of 'complete' stone-free status based on post-operative CT imaging.[12] The residual fragments were managed as indicated. The procedures

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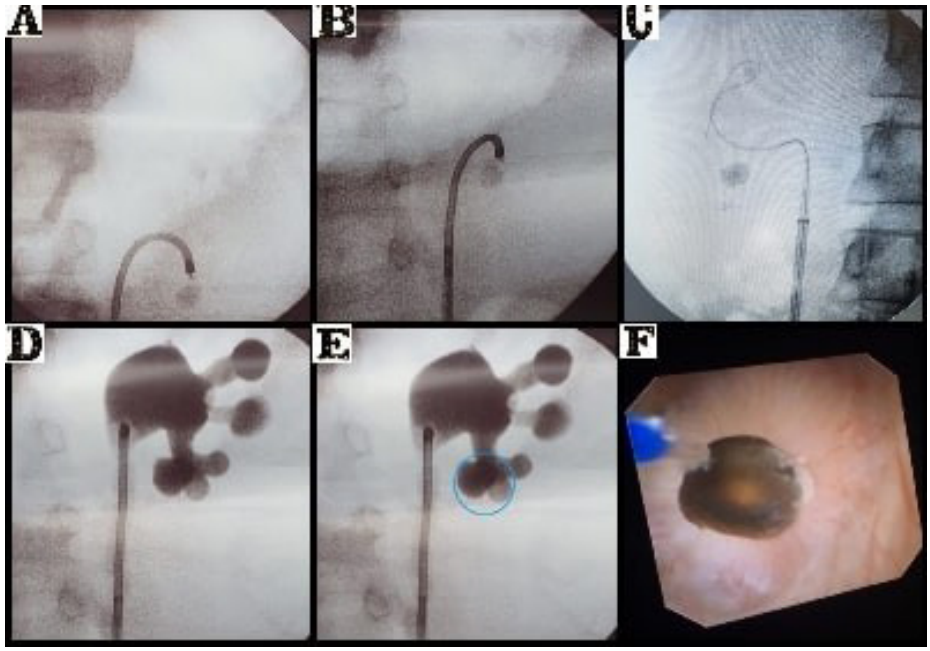

Figure 1: Stepwise imaging during RIRS for lower pole stone removal

A: Plain fluoroscopic image showing angled flexible scope with the stone in the lower pole at a difficult angle; B: Plain fluoroscopic image showing angled flexible scope with the stone in the lower pole at a difficult angle; C: Fluoroscopic image with ureteric access sheath in situ, glide wire in the system and a stone; D: Retrograde pyelography with the flexible scope up till pelvic ureteric junction; E: Same Retrograde pyelography, with the flexible scope up till pelvic ureteric junction, image with the labeled stone in lower pole at a very acute angle; F: Endoscopic image through a flexible scope with the laser in it targeting the stone in the lower pole.

were done by several surgeons experienced in RIRS, all with the same laser settings and procedural protocol. Postoperative stone clearance was assessed using non-contrast computed tomography (NCCT) after RIRS. Because of the retrospective nature of the study, the timing of postoperative CT was not uniform across all patients and was therefore recorded as documented in the medical records. This variability was considered when interpreting the reported stone-clearance rate. Key variables include:

- **Demographics:** Age; sex; Body Mass Index; geographical location.
- **Preoperative Data:** Medical history, number of stone episodes, and laboratory values including hemoglobin, creatinine.
- **Operative Information:** Size and position of calculi, anesthesia used, time taken to complete the operation, use of double pigtail stent or ureteric sheath, and intraoperative complications.
- **Postoperative Outcomes:** Stone clearance (complete or partial), residual fragments, complications, and hospital stay length.

All data analyses were done with the use of IBM SPSS, Version 27. For continuous variables, data was summarized as means, medians, and standard deviations, whereas frequencies and percentages were used for categorical data. t-tests for normally distributed data, Mann–Whitney U tests for non-normally distributed data, and Chi-square or Fisher's exact tests for categorical variables were conducted for comparative analyses. A p-value of less than 0.05 was set to define statistical significance.

Results

A total of 179 non-prestented patients who underwent retrograde intrarenal surgery (RIRS) using a 9.5 Fr ureteral access sheath were analyzed. Complete stone clearance was achieved in 150 patients (83.8%), whereas 29 patients (16.2%) had partial clearance. Baseline demographics, clinical characteristics, operative variables, and postoperative outcomes were compared between the two groups to identify factors associated with stone clearance status. Continuous variables were analyzed using independent samples t-test or Mann–Whitney U test as appropriate, while categorical variables were compared using the chi-square test.

Within the non-prestented cohort, patients with partial stone clearance had significantly larger stones than those with complete clearance (median 1.65 vs. 1.10

Table 1. Baseline, Operative, and Postoperative Characteristics According to Stone Clearance Status

Variable	Complete Clearance (n = 150)	Partial Clearance (n = 29)	p-value
Baseline and clinical characteristics			
Age (years), mean ± SD	44.47 ± 16.35	46.34 ± 13.16	0.561
Sex, n (%)			
└ Male	81 (54.0)	18 (62.1)	0.424
└ Female	69 (46.0)	11 (37.9)	
BMI, median (IQR)	23.0 (6)	24.7 (5)	>0.05
BMI category, n (%)			
└ Underweight	10 (6.7)	1 (3.4)	0.500
└ Healthy weight	92 (61.3)	15 (51.7)	
└ Overweight	33 (22.0)	10 (34.5)	
└ Obese	15 (10.0)	3 (10.3)	
Positive family history of stones, n (%)	2 (1.3)	2 (6.9)	0.064
Previous stone episodes, median (IQR)	0 (1)	0 (1)	>0.05
Stone size (cm), median (IQR)	1.10 (0.4)	1.65 (0.6)	<0.001
History of UTI, n (%)	23 (15.3)	6 (20.7)	0.474
Diuretics/antacids use, n (%)	4 (2.7)	0 (0.0)	0.374
History of stone formation, n (%)	60 (40.0)	14 (48.3)	0.407
Previous stone removal procedure, n (%)	43 (28.7)	10 (34.5)	0.530
Type of previous procedure, n (%)			
└ Lithotripsy	17 (11.3)	3 (10.3)	0.382
└ RIRS	1 (0.7)	0 (0.0)	
└ Other	22 (14.7)	8 (27.6)	
└ None	110 (73.3)	18 (62.1)	
Outcome of previous procedures, n (%)			
└ Satisfactory	25 (16.7)	7 (24.1)	0.468
└ Non-satisfactory	15 (10.0)	4 (13.8)	
└ No prior intervention	110 (73.3)	18 (62.1)	
Preoperative hemoglobin (g/dL), mean ± SD	12.20 ± 1.84	12.33 ± 2.10	0.735
Preoperative hematocrit (%), median (IQR)	36.0 (7.6)	36.0 (9.0)	>0.05
Preoperative WBC ($\times 10^9$/L), median (IQR)	8.0 (2.5)	9.0 (2.3)	0.011
Preoperative creatinine (mg/dL), median (IQR)	1.0 (0.3)	1.0 (0.6)	>0.05
Side of calculi, n (%)			
└ Left	73 (48.7)	11 (37.9)	0.289
└ Right	77 (51.3)	18 (62.1)	
Stone location, n (%)			

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└ Upper pole			
└ Middle pole			
└ Lower pole			
Operative characteristics			
Operative time (min), median (IQR)	72.5 (51)	90.0 (25)	>0.05
Laser time (min), median (IQR)	55.0 (37)	70.0 (25)	>0.05
Immediate perioperative complications, n (%)	13 (8.7)	6 (20.7)	0.054
Type of complication, n (%)			
└ Urosepsis (Grade III)	8 (5.3)	5 (17.2)	0.052
└ UTI/mild complications (Grade I–II)	5 (3.3)	1 (3.4)	
Postoperative DJ stent placement, n (%)	148 (98.7)	29 (100.0)	0.532
Postoperative outcomes			
Residual fragments on postoperative imaging, n (%)	0 (0.0)	29 (100.0)	<0.001
Postoperative WBC (×10^9/L), median (IQR)	8.8 (2.5)	10.0 (4.2)	>0.05
Additional procedures required, n (%)	4 (2.7)	21 (72.4)	<0.001
Length of hospital stay (days), median (IQR)	1 (1)	1 (1)	0.043
Residual fragment size (mm), median (IQR)	-	7.0 (5)	-
DJ stent removal time (days), median (IQR)	20 (14)	31 (38)	<0.001
Foley catheter removal time (days), median (IQR)	1 (1)	1 (2)	0.006

Footnotes: Values are presented as n (%), mean ± SD, or median (IQR), as appropriate. Continuous variables were compared using the independent-samples t-test or Mann–Whitney U test, as appropriate. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant. Residual fragment size is reported in millimeters (mm). Postoperative variables are presented as outcomes or correlates of clearance status and were not considered baseline predictors of stone clearance.

cm, p<0.001) and higher preoperative white blood cell counts (p=0.011). Demographic characteristics, BMI, stone laterality and location, previous stone history, preoperative hemoglobin, hematocrit and creatinine, and postoperative white blood cell count did not differ significantly between the groups. Operative time and laser time were also not significantly different between the complete- and partial-clearance groups (both p>0.05). Postoperative outcomes, including hospital stay, additional procedures, and timing of DJ stent and Foley catheter removal, differed between groups but were considered consequences or correlates of the postoperative clearance status rather than baseline predictors of stone clearance.

Discussion

Nephrolithiasis, or kidney stone disease, is a common urological condition with a rising global prevalence due to dietary and lifestyle changes. It may result in considerable morbidity, such as pain, hematuria, and UTIs, with larger stones possibly culminating in hydronephrosis and renal failure. Among various surgical modalities, RIRS has been recognized as a preferred minimal invasive procedure for managing renal stones measuring ≤2 cm, particularly when extracorporeal shock wave lithotripsy or percutaneous nephrolithotomy may not be feasible.[13]

In our series of non-prestented patients undergoing RIRS with a 9.5 Fr re-access ureteral access sheath, complete stone clearance was achieved in 83.8% of patients. This rate is comparable to clearance rates reported in several studies involving mixed pre-stented and non-prestented cohorts. In our study, larger stone size was significantly associated with partial stone clearance, with patients in the partial-clearance group having a greater median stone size than those achieving complete clearance. This finding is consistent with previous literature demonstrating that stone burden is an important determinant of the likelihood of complete clearance after RIRS. However, because all patients in our cohort were non-prestented and no prestented comparison group was included, our findings cannot determine whether stone size has a greater influence on clearance than preoperative stenting. Rather, our results indicate that, within a non-prestented popula-

Table 2. Comparison of stone clearance outcomes and the role of preoperative ureteral stenting in RIRS across published studies and the present cohort

Study (Year)	Study Design	Sample Size	Stent Status Compared	Access Sheath / Technique	Stone-Free / Clearance Rate	Operative Time (min)	Key Findings Relevant to Stone Clearance
Present study (2025)	Retrospective, single-center	179	Non-prestented only	9.5 Fr re-access UAS	83.8% complete clearance	72.5 (IQR 51)	High clearance without pre-stenting; partial clearance associated with larger stone size, higher pre-op WBC, residual fragments, and need for additional procedures
Ansari et al. (2025)14	Randomized controlled trial	126	Pre-stented vs non-prestented	UAS (size not specified)	85.3% vs 64.7%	58.8 vs 68.7	Pre-stenting improved access success and stone-free rate but increased resource utilization
Bai et al. (2021)15	Retrospective cohort	306	Pre-stented vs non-prestented	Flexible URS	Day 1: 69.0% vs 51.5%; Month 1: 89.2% vs 81.6%	53.8 vs 59.3	Pre-stenting improved early SFR but not 1-month SFR; no significant reduction in complications
Shields et al. (2009)16	Retrospective analysis	221	Pre-stented vs non-prestented	URS ± UAS	Overall success 86.9% (1 procedure)	Not specified	Success inversely related to stone size and burden; pre-stenting not independently significant
Senel et al. (2024)17	Matched-pair retrospective	376 (94 vs 282)	Pre-stented vs non-prestented	RIRS	77.7% vs 78.0%	Not specified	No difference in success or postoperative complications; pre-stenting reduced only minor intraoperative events

Footnotes:

- *Values are reported as percentages, means, or medians as presented in the original studies.*
- *Stone-free rate definitions varied across studies (early postoperative imaging vs delayed follow-up).*
- *UAS: ureteral access sheath; RIRS: retrograde intrarenal surgery; URS: ureteroscopy.*
- *In the present study, stone clearance was assessed using postoperative non-contrast CT, enabling accurate evaluation of residual fragments.*

tion undergoing RIRS with a 9.5 Fr re-access sheath, greater stone size is associated with a lower likelihood of complete clearance.

The high clearance rate observed in this cohort suggests that the use of a 9.5 Fr re-access ureteral sheath may permit successful RIRS without routine preoperative stenting in appropriately selected patients. However, this interpretation should be considered in the context of the study design and selection criteria, and it does not establish that non-stenting is equivalent or superior to preoperative stenting. Prospective comparative studies including both prestented and non-prestented patients are required to determine the independent contribution of preoperative stenting to ureteral access, stone clearance, complications, and procedural efficiency.

The success of RIRS requires certain parameters to be met, such as accessibility of the renal pelvis, ureteral dilation, and irrigation flow. Among the various options explored to improve the results of RIRS, the use of ureteral stents before surgery has garnered attention, thought to aid in ureteral entry and ensure a stone-free outcome. Nonetheless, the practice of ureteral stenting has remained controversial due to the availability of smaller-sized ureteral access sheaths. While several studies have compared outcomes between pre-stented and non-prestented patients, there is limited evidence specifically examining non-prestented patients using small-caliber (9.5 Fr) re-access ureteral sheaths. This gap in the literature justifies a focused evaluation of stone clearance and perioperative outcomes in this population.

In our series of non-prestented patients undergoing RIRS with a 9.5 Fr ureteral access sheath, an overall

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stone clearance rate of 83.8% was achieved. This is comparable to or exceeds stone-free rates reported in several studies with mixed pre-stented and non-prestented cohorts. While some analyses have shown higher clearance with pre-stenting, particularly for larger stones or larger-caliber sheaths, other well-matched studies reported no significant difference in success when stone characteristics were comparable. Within this non-prestented cohort, larger stone size was significantly associated with partial stone clearance. Utilizing a small caliber ureteral access sheath could potentially decrease the necessity for routine pre-stenting, facilitating atraumatic ureteral access and maintaining high rates of clearance. In clinical practice, not requiring routine pre-stenting procedures may improve patient comfort and resource management, as long as patient selection criteria are taken into account.

From a patient-management and healthcare-resource perspective, avoiding routine preoperative stenting may have potential advantages when clinically appropriate. A stent-free pathway could reduce stent-related symptoms and may avoid a subsequent visit or procedure for stent removal, thereby potentially reducing patient inconvenience and healthcare utilization. However, our study did not directly compare healthcare utilization, patient-reported discomfort, or costs between prestented and non-prestented patients. Therefore, these potential economic and patient-centered benefits should be considered hypothesis-generating rather than demonstrated effects of the present study. Prospective comparative studies incorporating patient-reported outcomes and formal cost-effectiveness analyses are warranted.

There are multiple strengths of this study. First, this study is among the more extensive single-center studies conducted solely for non-prestented RIRS using 9.5 Fr ureteral access sheaths. Second, multiple parameters of interest from the perioperative, laboratory, and procedural spheres were explored to point towards parameters of interest regarding stone clearance. Third, contemporary literature was also taken into consideration, which makes it easier to interpret the outcomes of stone clearance rate as per the results of this study. This study has several limitations. First, its retrospective single-center design limits generalizability and introduces the possibility of selection and information bias. Second, the study included only non-prestented patients and did not include a contemporaneous prestented comparison group. Therefore, the study cannot determine whether preoperative stenting improves ureteral access, stone clearance, procedural efficiency, or safety, nor can it establish that stone size is more important than preoperative stenting. Third, patients in whom RIRS could not be completed or who were converted to alternative stone treatment may have been excluded from the final analysis, which could introduce selection bias when assessing the feasibility of the 9.5 Fr sheath. The number and reasons for such exclusions were therefore documented separately where available. Fourth, postoperative CT timing may not have been uniform because of the retrospective nature of the study, which could have influenced the assessment of stone clearance. Finally, the study was not designed to identify independent predictors through multivariable regression, and some postoperative variables, including residual fragments, additional procedures, hospital stay, and catheter or stent removal timing, represent consequences or correlates of stone clearance rather than baseline predictors. Prospective multicenter comparative studies including both prestented and non-prestented patients, standardized postoperative imaging, and patient-reported and economic outcomes are needed to confirm these findings. Further research in which detailed imaging techniques are established prospectively in multiple institutions may be required for confirmation of these results. Trials could provide more information if they were stratified based on both stone sizes and sizes of access sheaths.

Conclusion

RIRS using a 9.5 Fr re-access ureteral sheath achieved a high rate of complete stone clearance in this cohort of non-prestented patients. Larger stone size was significantly associated with partial stone clearance within the non-prestented population. These findings suggest that RIRS with a 9.5 Fr re-access sheath may be feasible without routine preoperative stenting in appropriately selected patients. However, because no prestented comparison group was included, the present study cannot determine the relative effect of preoperative stenting on stone clearance or procedural outcomes. Prospective comparative studies are required to establish the role of preoperative stenting when using small-caliber re-access ureteral sheaths.

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Authors' Contribution Statement

AR contributed to the conception, design, acquisition, analysis, drafting of the manuscript, critical review of the manuscript, and final approval of the version to be published. NBN contributed to the design, acquisition, analysis, interpretation of data, and drafting of the manuscript. SM contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. NZ contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. AA contributed to the acquisition, analysis, and interpretation of data. SI contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. AA contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. AH contributed to the analysis, interpretation of data, drafting of the manuscript, and critical review of the manuscript. SI contributed to the acquisition, analysis, interpretation of data, critical review of the manuscript, and final approval of the version to be published. All authors are accountable for their work and ensure the accuracy and integrity of the study.

Conflict of Interest

Authors declared no conflict of interest

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Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.