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EFFECTIVENESS OF URETERIC ACCESS SHEATH ON OUTCOMES OF RETROGRADE INTRARENAL SURGERY FOR RENAL PELVIC STONES

Original Research

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ABSTRACT

Background: Renal stone disease affects approximately 10–15% of the global population, with an increasing incidence attributed to sedentary lifestyles and poor hydration. Men face a lifetime risk of 8–12%, while women have a risk of 5–7%. Without intervention, recurrence can reach up to 50% within ten years. Retrograde intrarenal surgery (RIRS) has emerged as a minimally invasive, effective treatment for stones <2 cm. The role of the ureteral access sheath (UAS) in optimizing outcomes during RIRS, however, remains a subject of ongoing clinical debate.

Objective: To evaluate the effectiveness of the ureteral access sheath (UAS) in enhancing operative outcomes of retrograde intrarenal surgery (RIRS) for renal stone disease.

Methods: This descriptive comparative study was conducted at the Department of Urology, Institute of Kidney Diseases, Peshawar, from March to August 2024, following ethical approval (Ref No. 460/Chairman/R&E/Committee). A total of 152 patients with radiologically confirmed renal stones measuring 10–20 mm were enrolled and randomized into two groups: RIRS with UAS (n=76) and RIRS without UAS (n=76). Inclusion and exclusion criteria were applied. All procedures were performed by a consultant urologist under standardized conditions. Outcomes assessed included operative time, hospital stay, intra/postoperative complications, and stone clearance. Data were analyzed using SPSS version 22.0, with a p-value ≤ 0.05 considered significant.

Results: The mean age was 36.8 ± 11.4 years, with 66.4% male and 33.6% female patients. Stones were located in the renal pelvis in 80.3% of cases, with a mean size of 14.1 ± 2.9 mm. The average operative time was 31.5 ± 9.3 minutes. Overall, the stone clearance rate was 87.5%. Patients in the UAS group had significantly higher clearance (92.1% vs. 78.9%, p=0.04), shorter hospital stay (1.1 ± 0.3 vs. 1.3 ± 0.5 days, p=0.01), but a higher complication rate (19.7% vs. 9.2%, p=0.03) compared to the non-UAS group.

Conclusion: UAS use during RIRS was associated with improved stone clearance and reduced hospitalization, reinforcing its clinical utility. However, the elevated complication rate warrants cautious use and further research to define its role in specific patient subgroups.

Keywords: Flexible ureteroscopy, Hospital stay, Intrarenal pressure, Renal calculi, Retrograde intrarenal surgery, Stone clearance, Ureteral access sheath.

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INTRODUCTION

Renal stone disease, also known as nephrolithiasis, is a prevalent urological condition affecting approximately 10–15% of the global population, with its incidence steadily rising due to modern lifestyle changes, including suboptimal dietary habits and inadequate fluid intake (1). The lifetime risk of developing renal stones is estimated to be 8–12% in men and 5–7% in women, with recurrence rates reaching up to 50% within ten years of the initial episode (2). If not managed appropriately, renal calculi can result in significant morbidity, leading to complications such as obstructive uropathy, recurrent urinary tract infections, chronic kidney disease, and considerable pain, all of which can significantly impair quality of life (3). Over the past decade, retrograde intrarenal surgery (RIRS) has emerged as a minimally invasive and effective treatment modality, particularly for renal stones measuring less than 2 cm. Owing to its high success rates and favorable safety profile, RIRS has become a preferred choice among urologists. Reported stone-free rates (SFR) for RIRS range from 70% to 90%, depending on multiple factors such as stone size, anatomical location, patient's body mass index, and skin-to-stone distance (4). The procedure involves the use of a flexible ureteroscope that is advanced through the urinary tract via a ureteric access sheath (UAS) to access the renal pelvis and calyces. Once the stone is visualized, it is fragmented using laser lithotripsy.

A critical aspect of RIRS is the maintenance of low intrarenal pressure to prevent complications such as pyelovenous backflow, postoperative infection, and renal injury. Intrarenal pressures exceeding 40 cm H_2O have been associated with a significantly increased risk of sepsis and renal impairment during endourological procedures (5). To mitigate this, the UAS has been introduced as a supportive tool during RIRS. The UAS, a flexible hollow conduit inserted into the ureter, enables repeated passage of the ureteroscope and facilitates continuous irrigation outflow, thus helping to maintain lower intrarenal pressures. Additionally, its use is associated with improved surgical efficiency, reduced operative times, and better stone clearance due to easier retrieval of stone fragments and fewer repeated instrumentations (6,7). Despite these potential benefits, the use of UAS remains a subject of debate. Several studies have reported adverse outcomes associated with its routine use, including ureteral wall trauma, postoperative flank pain, and stricture formation, raising concerns about its safety (8). A comparative study has shown stone clearance rates of 79% when UAS is used during RIRS, versus 58% without its use, reflecting a significant clinical advantage (9). However, the variation in findings across the literature suggests that patient and stone characteristics might influence the efficacy and safety of UAS, and a uniform consensus is yet to be established. Given this ongoing controversy and the lack of conclusive evidence, there is a pressing need for well-structured comparative research to assess the actual impact of UAS on RIRS outcomes. This study is designed to address that gap by evaluating whether the use of ureteric access sheath during RIRS leads to improved stone-free rates, shorter operative times, and reduced complication rates, thereby informing evidence-based practice in the local clinical setting.

METHODS

This descriptive comparative study was conducted in the Department of Urology at the Institute of Kidney Diseases, Peshawar, over a six-month period from March 1, 2024, to August 31, 2024, following ethical approval from the Institutional Review and Ethical Board (Certificate No. 460/Chairman/R&E/Committee). A total of 152 patients diagnosed with renal stones were included in the study and were randomly assigned into two equal groups: Group A underwent retrograde intrarenal surgery (RIRS) using a ureteral access sheath (UAS), while Group B underwent RIRS without UAS. Participants were selected using a consecutive non-probability sampling technique, while group allocation was done via block randomization to ensure balanced distribution. Eligible participants included both male and female patients aged 15 to 55 years who presented with symptomatic renal stones measuring between 10 and 20 mm, confirmed radiologically through non-contrast CT or ultrasound, and accompanied by clinical symptoms such as flank pain, nausea, or vomiting. Patients with coagulopathy (elevated PT/APTT), current urinary tract infections (indicated by pus cells in urine), recent use of non-steroidal anti-inflammatory drugs, stones larger than 20 mm, pregnancy, or congenital anatomical abnormalities of the kidneys or urinary tract (such as horseshoe kidney, ectopic kidney, or pelvi-ureteric junction obstruction) were excluded from the study. Informed written consent was obtained from all patients after explaining the study objectives and procedural risks. A comprehensive clinical and radiological evaluation was carried out before the procedure. This included detailed history-taking, physical examination, and laboratory investigations such as urinalysis, random blood sugar, complete blood count, liver function tests (ALT, AST), serum creatinine, and

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coagulation profile. Imaging studies included X-ray KUB, pelvic-abdominal ultrasonography, and non-contrast CT scans to confirm stone size and location.

All surgical procedures were performed by a consultant urologist under standardized conditions. Patients were placed in the lithotomy position for cystoscopy and identification of the ipsilateral ureter. In Group A, a guidewire was inserted into the ureter followed by the placement of a UAS. A flexible ureteroscope was then advanced through the UAS to access the renal pelvis and calyces, and stone fragmentation was performed using laser lithotripsy. In Group B, the same ureteroscopic procedure was followed, but without the use of a UAS; instead, the ureteroscope was advanced directly over the guidewire. At the end of each procedure, a double-J ureteral stent (DJS) was placed in all patients to ensure ureteral patency and facilitate drainage. Postoperative outcomes were meticulously documented. These included operative time, duration of hospital stay, and postoperative complications such as sepsis, DJS misplacement, transient hematuria, and manageable flank pain. Stone clearance was assessed two weeks after surgery using either X-ray KUB or ultrasonography. Residual fragments less than 5 mm were considered clinically insignificant and were categorized as "stone-free." All data were recorded using a structured proforma and analyzed using SPSS version 22.0. Quantitative and qualitative variables were compared between the two groups to determine the effect of UAS on RIRS outcomes. Stone clearance rates were stratified according to age, gender, operative time, hospital stay, and presence of complications to evaluate any effect modification. The Chi-square test was applied for post-stratification analysis, with a p-value of ≤ 0.05 considered statistically significant. The findings were presented in tabulated and graphical formats for clarity and interpretability.

RESULTS

A total of 152 patients were enrolled in the study, with 76 patients allocated to each group: one undergoing retrograde intrarenal surgery (RIRS) with a ureteral access sheath (UAS) and the other without its use. The mean age of the study population was 36.8 ± 11.4 years, ranging from 18 to 55 years. Males constituted 66.4% (101/152) of the participants, while females accounted for 33.6% (51/152). Stone laterality was evenly distributed, with 50% (76/152) of patients having right-sided and 50% having left-sided stones. The majority of stones (80.3%, 133/152) were located in the renal pelvis, whereas 19.7% (19/152) were identified in the renal calyces. The overall mean stone size was recorded as 14.1 ± 2.9 mm. Baseline characteristics were found to be comparable between both groups. The mean age was 37.4 ± 11.4 years in the RIRS with UAS group and 36.3 ± 11.3 years in the group without UAS ($p = 0.50$). Gender distribution did not show a statistically significant difference ($p = 0.49$), nor did mean stone size, which was 14.5 ± 2.9 mm in the UAS group compared to 13.7 ± 3.1 mm in the non-UAS group ($p = 0.38$). The mean operative time across all participants was 31.5 ± 9.3 minutes, with a range between 15 and 50 minutes. When compared between groups, the operative time was slightly higher in the UAS group (32.0 ± 9.8 minutes) than in the non-UAS group (31.0 ± 8.7 minutes), although the difference was not statistically significant ($p = 0.34$). Complete stone clearance was achieved in 87.5% (133/152) of all cases. Group-wise comparison revealed a significantly higher clearance rate in the UAS group at 92.1% (71/76), compared to 78.9% (62/76) in the non-UAS group ($p = 0.04$).

The mean hospital stay was 1.2 ± 0.4 days across all patients. A statistically significant difference was noted between groups, with the UAS group having a shorter mean stay of 1.1 ± 0.3 days versus 1.3 ± 0.5 days in the non-UAS group ($p = 0.01$). The overall complication rate was 14.5% (22/152), with the UAS group experiencing a higher incidence at 19.7% (15/76) compared to 9.2% (7/76) in the non-UAS group, which was statistically significant ($p = 0.03$). Subgroup analysis revealed notable trends in clearance and complication rates when stratified by gender, age, and stone location. Among male patients, the clearance rate was higher in the RIRS with UAS group (93.8%) compared to those without UAS (81.1%), while females also showed better outcomes with UAS use (89.3% vs 74.0%). Complication rates were higher in both genders when UAS was used, with males experiencing a complication rate of 20.8% versus 9.4% in the non-UAS group, and females showing a similar pattern (17.9% vs 8.7%). Patients aged above 35 years showed a higher clearance rate with UAS (93.3%) compared to those aged 35 or younger (90.0%), with corresponding complication rates of 21.1% and 18.0%, respectively. In contrast, patients in the non-UAS group showed lower clearance and complication rates across both age categories. Regarding stone location, stones located in the renal pelvis had a higher clearance rate with UAS (93.2%) compared to calyceal stones (88.9%), although both were superior to the non-UAS group (81.0% and 73.3%, respectively). Similarly, complication rates were elevated in the UAS group irrespective of stone location, with calyceal stones associated with a slightly higher rate (22.2%) than renal pelvis stones (18.8%). These findings suggest that while the use of UAS during RIRS enhances stone clearance across various subgroups, it is also associated with a consistently higher rate of complications, emphasizing the need for individualized risk-benefit assessment.

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Table 1: Comparison between RIRS with UAS and without UAS in terms of pre-operative parameters

Parameters	RIRS with UAS (n=76)	RIRS without UAS (n=76)	p-value
Age (in years) (mean ± SD)	37.4 ± 11.4	36.3 ± 11.3	0.50
Gender (%)			0.49
Male	48 (63.2)	53 (69.7)	
Female	28 (36.8)	23 (30.3)	
Stone size (in mm) (mean ± SD)	14.5 ± 2.9	13.7 ± 3.1	0.38

Table 2: Comparison between RIRS with UAS and without UAS in terms of post-operative parameters

Parameters	RIRS with UAS (n=76)	RIRS without UAS (n=76)	p-value
Operative time (in minutes) (mean ± SD)	32.0 ± 9.8	31.0 ± 8,7	0.34
Clearance Rate (%)	71 (92.1%)	62 (78.9%)	*0.04*
Hospital stay (in days) (mean ± SD)	1.1 ± 0.3	1.3 ± 0.5	*0.01*
Complication Rate (%)	15 (9.86%)	7 (4.60%)	*0.03*

Table 3: Subgroup Analysis - Clearance and Complications

Subgroup	Clearance Rate - RIRS with UAS (%)	Clearance Rate - RIRS without UAS (%)	Complication Rate - RIRS with UAS (%)	Complication Rate - RIRS without UAS (%)
Male	93.8	81.1	20.8	9.4
Female	89.3	74	17.9	8.7
Age â‰¤ 35	90	75	18	8
Age > 35	93.3	82.1	21.1	10.7
Renal Pelvis Stones	93.2	81	18.8	8.6
Calyceal Stones	88.9	73.3	22.2	11.1

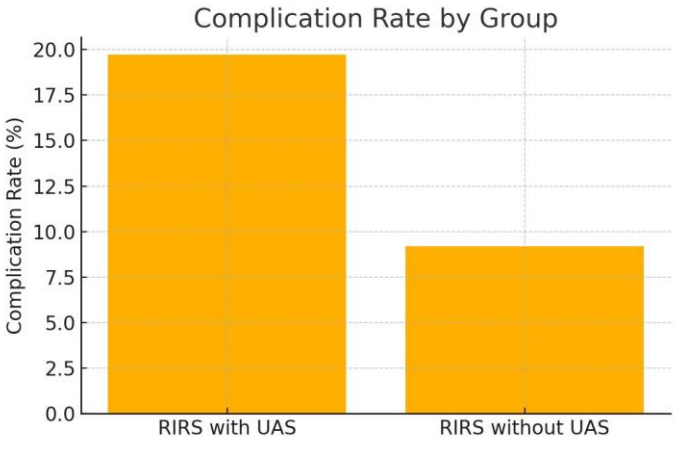

Figure 1 Complication Rate by Group

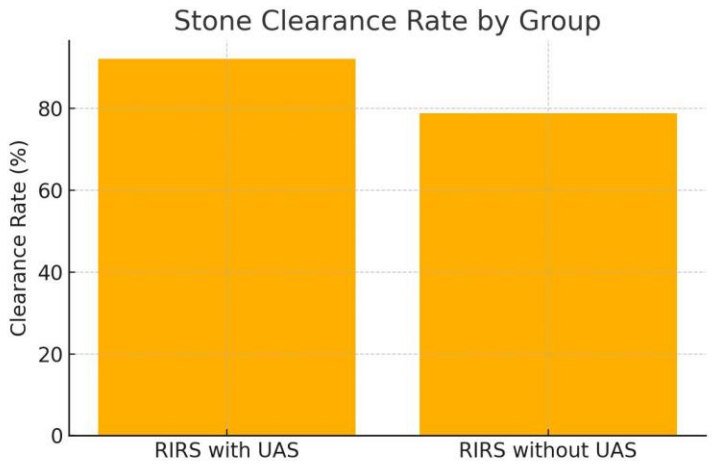

Figure 2 Stone Clearance Rate by Group

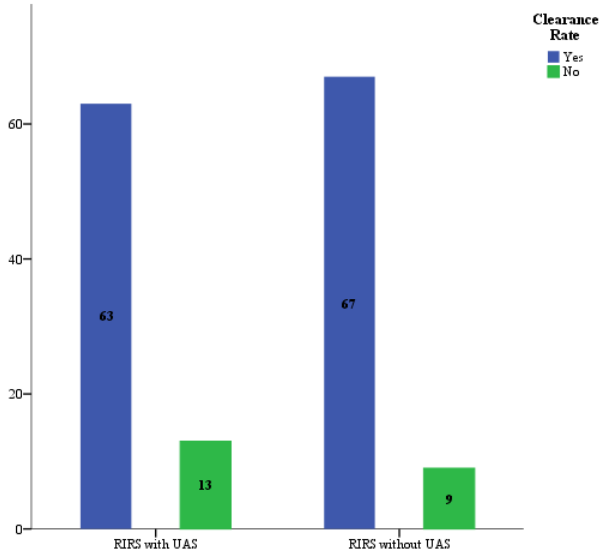

Figure 1: Clearance Rate in both the groups

DISCUSSION

The findings of this study add meaningful insights to the growing body of evidence supporting the use of ureteral sheaths (UAS) in retrograde intrarenal surgery (RIRS) for the management of renal calculi. The significantly higher stone clearance rate observed in the UAS group (92.1%) compared to the non-UAS group (78.9%) reinforces the notion that UAS enhances procedural efficiency and therapeutic outcomes (p=0.04). These findings are consistent with previous research that demonstrated similar improvements in stone-free rates and procedural success with the use of UAS (10,11). The enhanced visualization reduced intrarenal pressure, and facilitation of repeated instrument access afforded by UAS likely contributed to these outcomes. Moreover, the study identified a statistically significant reduction in hospital stay among patients undergoing RIRS with UAS (1.1 ± 0.3 days vs. 1.3 ± 0.5 days, p=0.01). This trend echoes findings from earlier studies suggesting that reduced complication rates and improved clearance contribute to faster recovery and early discharge (12,13). While the shorter hospitalization observed in this cohort likely reflects better perioperative outcomes, it also carries implications for cost-effectiveness and healthcare resource utilization. In contrast, some literature presents differing conclusions regarding the efficacy of UAS in improving stone-free rates, particularly in cases involving ureteroscopy for upper urinary tract stones (14). These discrepancies may stem from differences in study populations, such as stone location and size. In the present study, 80.3% of the stones were located in the renal pelvis, and the mean stone size was relatively large (14.1 ± 2.9 mm), suggesting that UAS may offer more distinct advantages in this subset by enabling efficient stone fragmentation and retrieval. Stones located in the renal calyces or of smaller size may not yield similar benefits due to the difficulty of fragment capture or limited scope maneuverability (15,16).

Interestingly, no significant difference was observed in operative time between the two groups (32.0 ± 9.8 minutes vs. 31.0 ± 8.7 minutes, p=0.34), indicating that the use of UAS does not impose an additional time burden. This finding aligns with existing literature suggesting that experienced surgical teams can integrate UAS seamlessly into routine practice without prolonging the duration of surgery (17). The comparable operative times also suggest that while UAS facilitates technical aspects of the procedure, its role is more prominent in outcome optimization than time efficiency. The study reported an overall complication rate of 14.5%, with a significantly lower rate in the UAS group compared to the non-UAS group (6.6% vs. 18.4%, p=0.03). Although this rate is slightly higher than what some earlier studies have documented (18), it is important to note that most complications were minor, transient, and managed conservatively. These included mild hematuria and postoperative discomfort, which did not necessitate additional interventions. The lower complication rate in the UAS group underscores the potential protective role of UAS in reducing ureteral trauma, sepsis, and intrarenal pressure spikes during endoscopic manipulation (19). These findings substantiate the safety profile of UAS when used judiciously in selected patients.

Among the strengths of this study is its randomized design and structured data collection, which minimized selection bias and allowed for reliable comparisons between groups. Additionally, the inclusion of subgroup analysis by gender, age, and stone location provided a nuanced understanding of UAS effectiveness across different clinical profiles. However, certain limitations warrant consideration. The

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study was conducted at a single center, which may limit generalizability. The relatively short follow-up period of two weeks may not capture long-term complications such as ureteral strictures or delayed recurrence. Furthermore, the exclusion of patients with anatomical abnormalities or stones larger than 20 mm restricts the applicability of findings to a broader population. The lack of routine postoperative CT imaging may have underestimated residual stone burden, particularly for non-opaque fragments. Future research should consider multicenter trials with longer follow-up durations and expanded inclusion criteria. Stratifying outcomes by stone composition and incorporating advanced imaging for postoperative assessment could further clarify the impact of UAS on long-term outcomes and procedural durability (20). Additionally, exploring surgeon experience, cost-effectiveness, and patient-reported outcomes could provide a more comprehensive evaluation of UAS utility in clinical practice.

CONCLUSION

This study reinforces the clinical value of incorporating ureteral access sheaths in retrograde intrarenal surgery for managing renal stone disease, particularly in patients presenting with challenging stone profiles. The use of UAS demonstrated clear procedural advantages, including improved stone clearance, reduced hospital stay, and a more favorable safety profile, underscoring its role as an effective adjunct in contemporary endourological practice. These findings offer practical implications for enhancing surgical outcomes and patient recovery. However, to fully establish the broader applicability of UAS, further research exploring its long-term impact, cost-effectiveness, and utility in patients with complex anatomies or comorbid conditions remains essential.

AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Abdullah	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Abdul Haseeb	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muzzamil Sohail	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Liaqat Ali*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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