THE PLANET

Original Article

Efficacy, safety, and Outcomes of Retrograde Intrarenal Surgery for Upper Ureteric and Renal Stones: A Single-Center Retrospective Study of 382 Cases

Abul Bashar Shahriar Ahmed[1*], Mohammad Hasibul Islam[2], Tanbir Al-Misbah[3], ATM Mowladad Chowdhury[4], Tapu Nag[5], Alauddin Pavel[6], Mahbub Hasan[7], Shakila Ashfia Lily[8]

ARTICLE INFO

Received: 18 May 2026
Accepted: 23 May 2026
Published Online: 26 May 2026

DOI: 10.5281/zenodo.20387559

Volume: 9, Number: 3, Page: 200-206

e-ISSN: 2789-5912
ISSN: 2617-0817

*Corresponding author

ABSTRACT

Introduction: Retrograde intrarenal surgery (RIRS) with holmium laser lithotripsy has become a primary minimally invasive treatment for upper urinary tract stones. However, large single-centre series reporting both efficacy and safety for stones up to 3 cm remain limited. **Objective**: To evaluate the efficacy, safety, and perioperative outcomes of RIRS for upper ureteric and renal stones. **Methods & Materials**: This retrospective single-centre study included 382 adult patients (62.3% male, mean age 46.2 years) with symptomatic upper ureteric or renal calculi ≤3 cm who underwent RIRS between July 2018 and January 2026. The primary outcome was stone-free rate (SFR) defined as no residual fragments >2 mm at 4-week follow-up. Secondary outcomes included complications graded according to the Clavien-Dindo classification, operative time, laser time, hospital stay, and re-intervention rate. **Results**: The overall SFR was 92.5% (353/382), with residual fragments >2 mm in 7.5% (29/382). Mean total operative time was 69.3 minutes, mean laser time 37.5 minutes, and mean postoperative hospital stay 2.5 days. Intraoperative complications included pelvicalyceal bleeding requiring transfusion (1.3%), pelvicalyceal injury (2.8%), and ureteric injury related to the ureteral access sheath (3.9%). Postoperative complications were mostly mild: fever requiring medication (16.7%, grade II), persistent haematuria (10.9%, grade I), and sepsis requiring ICU admission (0.78%, grade IV). No grade V (death) complications occurred. Re-intervention for residual fragments was performed in 7.5% (repeat RIRS 7.0%, PCNL 0.5%). **Conclusion**: RIRS with holmium laser lithotripsy is highly effective and safe for upper ureteric and renal stones up to 3 cm, achieving a 92.5% stone-free rate with low major morbidity and short hospital stay. These results support RIRS as a first-line minimally invasive option in high-volume centers.

Keywords: *Retrograde intrarenal surgery; upper ureteric stones; renal stones; holmium laser; stone-free rate; complications.*

1. *Associate Professor, Department of Urology, Enam Medical College and Hospital, Savar, Dhaka, Bangladesh (ORCID: 0009-0003-4149-2304)*
2. *Associate Professor, Department of Urology, Enam Medical College and Hospital, Savar, Dhaka, Bangladesh (ORCID: 0009-0006-4143-0244)*
3. *Assistant Professor, Department of Urology, Ibrahim Medical College and BIRDEM General Hospital, Dhaka, Bangladesh (ORCID: 0000-0002-3055-9185)*
4. *Professor, Department of Urology, Ibrahim Medical College and BIRDEM General Hospital, Dhaka, Bangladesh (ORCID: 0009-0006-0061-5760)*
5. *Assistant Registrar, Department of Urology, Enam Medical College and Hospital, Savar, Dhaka, Bangladesh (ORCID: 0009-0008-2255-6305)*
6. *Indoor Medical Officer, Department of Urology, Enam Medical College and Hospital, Savar, Dhaka, Bangladesh (ORCID: 0009-0009-8302-6137)*
7. *Indoor Medical Officer, Department of Urology, Enam Medical College and Hospital, Savar, Dhaka, Bangladesh (ORCID: 0009-0003-6857-4510)*
8. *Core Surgical trainee, Department of Urology, Enam Medical College and Hospital, Savar, Dhaka, Bangladesh (ORCID: 0009-0008-3884-079X)*

INTRODUCTION

Urolithiasis represents one of the most common disorders of the urinary tract, affecting up to 15% of the global population at some point in life, with a rising prevalence attributed to changes in dietary habits, obesity, and global warming[1,2]. The lifetime risk of stone formation is approximately 10–15% in men and 5–10% in women, and recurrence rates approach 50% within five years of the first episode[3]. Upper ureteric and renal stones, in particular, pose substantial clinical challenges due to their potential to cause obstruction, recurrent infection, and progressive loss of renal function if not managed effectively[4]. Consequently, the search for minimally invasive treatments that maximise stone clearance while minimising patient morbidity has become a central focus of modern endourology.

Historically, large upper tract stones were managed by open surgery, which carried high rates of complications and prolonged convalescence. The introduction of shock wave lithotripsy (SWL) in the 1980s revolutionised stone treatment, but SWL has limited efficacy for larger (>20 mm), harder (e.g., calcium oxalate monohydrate or cystine), or lower-pole stones[5]. Percutaneous nephrolithotomy (PCNT) became the gold standard for large renal calculi, providing high stone-free rates (SFRs) at the cost of a nephrostomy tract, with attendant risks of bleeding, renal injury, and prolonged hospital stay[6]. Against this backdrop, retrograde intrarenal surgery (RIRS) using flexible ureteroscopes emerged as a compelling alternative. RIRS allows the urologist to access any part of the pelvicalyceal system via the natural urinary passages, without a cutaneous incision. With advances in flexible ureteroscope technology (smaller calibre, improved deflection, higher image quality) and the widespread use of holmium laser lithotripsy, RIRS has become a standard treatment for renal stones ≤20 mm and a viable option for selected larger stones[7].

The clinical efficacy of RIRS is typically measured by the stone-free rate, defined as the absence of residual fragments >2–4 mm on postoperative imaging. Published SFRs range from 65% to 94%, depending on stone burden, location (lower-pole stones being less favourable), stone composition, and surgeon experience[8–9]. A systematic review by Donaldson et al. (2015) comparing SWL, RIRS, and PCNL for lower-pole stones found that RIRS achieved significantly higher SFRs than SWL, with a morbidity profile intermediate between SWL and PCNL[7]. More recently, the CROES (Clinical Research Office of the Endourological Society) global study

reported SFRs of approximately 77% for RIRS with stones >10 mm, reinforcing its role as an effective minimally invasive modality[10].

Regarding safety, RIRS is generally well tolerated. The overall complication rate ranges from 10% to 30%, but the majority are Clavien-Dindo grade I–II events, including transient fever, haematuria, and mild ureteral mucosal injury[11]. Serious complications such as ureteral avulsion, perforation, or stricture formation occur in less than 2% of cases. Postoperative infectious complications, including systemic inflammatory response syndrome (SIRS) and urosepsis, remain a concern, with reported rates of 5–15%, particularly in patients with pre-existing bacteriuria or large stone volumes[12]. The use of a ureteral access sheath (UAS) facilitates repeated passage of the flexible ureteroscope and improves intraoperative irrigation, but it carries a risk of ureteral wall injury, as documented by Traxer and Thomas in a prospective evaluation[13]. Despite these risks, the safety profile of RIRS compares favourably to PCNL, especially in terms of bleeding and need for blood transfusion.

Current clinical guidelines reflect the maturation of RIRS as a primary treatment option. The European Association of Urology (EAU) guidelines recommend RIRS as a first-line therapy for renal stones of 10–20 mm and as a second-line option after failed SWL for stones <10 mm[4]. The American Urological Association (AUA) similarly endorses RIRS for patients in whom SWL is not ideal, such as those with lower-pole stones, obesity, or bleeding diatheses[5]. The International Alliance of Urology (IAU) has also published detailed recommendations for optimizing RIRS outcomes, emphasizing preoperative imaging, antibiotic prophylaxis, and intraoperative techniques to minimize complications[14].

However, despite the wealth of published data, most studies are limited by small sample sizes, heterogeneous patient populations, or a lack of standardized follow-up. Furthermore, few large single-centre series have simultaneously evaluated both upper ureteric and renal stones using a uniform RIRS protocol. Outcomes can vary significantly based on center volume, surgeon expertise, and local stone demographics, underscoring the need for real-world data from high-volume institutions.

We conducted a retrospective analysis of 382 patients who underwent RIRS for upper ureteric and renal stones. The primary goal was to evaluate efficacy, including stone-free rate and need for auxiliary procedures. Secondary goals included safety (complications graded by Clavien-Dindo), operative parameters (mean time and hospital stay), and predictors of success and complications. This large cohort aims to provide current evidence to guide patient selection, preoperative counselling, and quality benchmarking for RIRS.

OBJECTIVE

General Objective

This study aims to assess the overall effectiveness, safety, and clinical results of retrograde intrarenal surgery (RIRS) with holmium laser lithotripsy for treating upper ureteric and renal stones.

Specific Objectives

1. To determine the stone-free rate (SFR) after RIRS, defined as no residual fragments >2 mm on endoscopy and imaging at 4-week follow-up.
2. To evaluate RIRS safety by documenting intraoperative and postoperative complications using the Clavien-Dindo system.
3. To analyze perioperative outcomes such as total operative time, laser activation time, length of postoperative hospital stays, and the re-intervention rate for residual fragments.

METHODS & MATERIALS

This retrospective, single-centre study was conducted at the Department of Urology, Enam Medical College & Hospital, from July 2018 to January 2026. The study included 382 adult patients presenting with upper ureteric or renal stones who underwent retrograde intrarenal surgery (RIRS) with holmium laser lithotripsy. Surgical procedures were performed by three experienced consultant urologists. The study strictly followed the ethical standards set forth by the Declaration of Helsinki (2013 revision). Approval was granted by the Institutional Ethics Committee of Enam Medical College & Hospital before data collection and retrospective review. All patient data were anonymized and de-identified prior to analysis to ensure confidentiality. Written informed consent was obtained from each patient prior to surgery, with comprehensive information provided regarding benefits, risks, and available alternatives. As the retrospective review did not involve any additional procedures or deviations from routine clinical practice, the ethics committee waived the requirement for separate consent for chart review.

Inclusion criteria:

1. Individuals aged 18 years or older.
2. Both genders considered.
3. Presence of symptomatic upper ureteric or renal calculi measuring up to 3 cm in maximum diameter, confirmed through imaging.

Exclusion criteria:

1. Active urinary tract infection
2. Pregnancy
3. Severe anatomical obstruction that prevents safe passage of the ureteroscopee

Data Collection

Baseline demographic and clinical characteristics, intraoperative parameters, and postoperative outcomes were retrieved from the institutional hospital database. Recorded variables included age, gender, body mass index (BMI), stone laterality, stone location, preoperative hydronephrosis, preoperative double-J (DJ) stenting, and presenting symptoms. Intraoperative data included anaesthesia type, respiratory control, table position, surgeon's position, stone handling technique (dusting, fragmentation, popcorning, or combined), total operative time, and laser activation time.

Primary and Secondary Outcomes

The primary outcome was the stone-free rate (SFR), which was defined as no residual fragments larger than 2 mm seen during endoscopy at the end of the procedure. This was verified by postoperative imaging—such as kidney-ureter-bladder X-ray, ultrasound, or non-contrast CT—at the 4-week follow-up. The secondary outcomes included intra- and postoperative complications, classified according to the Clavien-Dindo grading system. We also recorded the total operative time, from cystoscopy to the end of laser lithotripsy, along with the length of postoperative hospital stay. Finally, we monitored the re-intervention rate for residual fragments, whether through repeat RIRS or percutaneous nephrolithotomy (PCNL).

Surgical Technique

All patients signed informed consent after discussions on the benefits, risks, alternative treatments, and potential need for staged procedures. RIRS was conducted under general or spinal anesthesia with the patient in the lithotomy position. A single dose of ceftriaxone was given intravenously before surgery; in some cases, intravenous amikacin was also administered.

The procedure started with standard cystoscopy and removal of any existing DJ stent. A guidewire (Zebra™, 0.035 in × 150 cm) was inserted into the ureter under C-arm guidance. Semi-rigid ureteroscopy was used to observe the ureteral orifice and to dilate the ureter actively. A 10-12 Fr ureteral access sheath (UAS) was then advanced over the guidewire and positioned about 1 cm below the ureteropelvic junction or just below the upper ureteric stone. If UAS insertion was not possible, the back-loading

technique—inserting the flexible ureteroscope over the guidewire without an access sheath—was attempted. If this also failed, the procedure was stopped, a DJ stent was placed, and surgery was postponed for two weeks.

After successfully inserting the flexible ureteroscope (fURS), gravity-based irrigation (height: 50 cm) was used, sometimes supplemented by hand pumping as needed. Stones were fragmented with a holmium laser using a 272 µm fiber. Laser settings were typically 1.0-1.5 J at 8-10 Hz, adjusted based on stone size, density, and surgeon preference. Fragments smaller than 2 mm were left to pass naturally, while larger fragments (>2 mm) were retrieved with a basket.

At the end of the procedure, a DJ stent was placed in selected cases and left in place for 2-4 weeks, at the surgeon's discretion.

Postoperative Follow-up

All patients had a kidney-ureter-bladder (KUB) X-ray on the first day after surgery to verify stent placement and detect any remaining significant fragments. Patients were usually discharged on postoperative day 2 if they showed no signs of distress or urinary issues. A routine follow-up with ultrasonography and KUB was scheduled at 4 weeks.

Statistical Analysis

Data were analysed using descriptive statistics. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. All analyses were performed using IBM SPSS Statistics (version not specified). A p-value <0.05 was considered statistically significant where applicable.

RESULTS

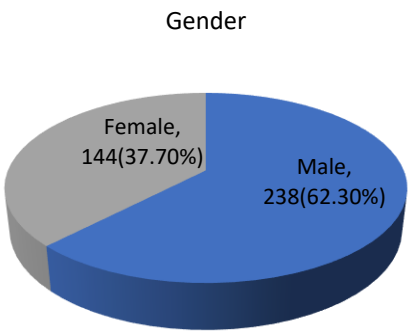

Figure 1 Gender distribution of the study patients (*n*=382).

Of the 382 study patients, 238 were male, accounting for 62.3% of the cohort. There were 144 female patients, representing 37.7% of the group (*Figure 1*).

The results are organized based on the study's specific objectives: first, the stone-free rate as the primary efficacy outcome; second, the safety profile, including intraoperative and postoperative complications graded by Clavien-Dindo; and third, perioperative outcomes such as operative time, laser time, hospital stay, and re-intervention rate. Patient demographics and baseline characteristics are detailed in *Table I*.

Table I
Demographic characteristics of the study patients (*n*=382).

Parameter		Value
Age (years) mean±SD		46.2 ±14.8
BMI (kg/m²), mean±SD		26.3 ± 4.6
Surgical side	Right	129 (33.7%)
	Left	142 (37.1%)
	Bilateral	111 (29.1%)
Recurrent stone former		78 (20.4%)

A total of 382 patients were enrolled, with an average age of 46.2 years (SD 14.8). Most patients (45.8%) were between 35 and 55 years old. The average body mass index (BMI) was 26.3 ± 4.6 kg/m². Left-sided stones were the most common, occurring in 37.1% of cases, while bilateral procedures were performed in 29.1% of patients. Recurrent stone formers made up 20.4% of the study population (*Table II*).

Table II
Clinical presentation and baseline renal status of the study patients (*n*=382).

Parameter		Value
Symptoms, n (%)	Loin pain only	227 (59.4%)
	Haematuria only	68 (17.8%)
	Both loin pain and haematuria	73 (19.1%)
	Incidental finding	14 (3.7%)
Pre-operative hydronephrosis		246 (64.4%)
Elevated creatinine		106 (27.7%)
Normal kidney anatomy		332 (86.9%)

Loin pain was the most common initial symptom, affecting 59.4% of patients, while 19.1% experienced both loin pain and haematuria. Pre-operative hydronephrosis was detected in 64.4% of cases. Elevated baseline serum creatinine (>1.2 mg/dL) was found in 27.7% of patients. Normal kidney anatomy was observed in 86.9% of cases (*Table III*).

Table III
Stone location and pre-operative stenting of the study patients (*n*=382).

Parameter		Value
Stone location, n (%)	Renal pelvis	118 (30.8%)
	Upper calyx	28 (7.3%)
	Middle calyx	12 (3.1%)
	Lower calyx	86 (22.5%)
	Multiple	138 (36.1%)
Pre-operative DJ stent	No	241 (63.1%)
	Yes	141 (36.9%)

Stones were most often found in multiple sites (36.1%), then in the renal pelvis (30.8%), and the lower calyx (22.5%). Preoperative DJ stenting was done in 36.9% of patients. The imaging techniques used included X-ray KUB (89.0%), NCCT KUB (81.9%), and ultrasound KUB (69.1%) *Table IV*.

Table IV
Intraoperative characteristics of the study patients (*n*=382).

Parameter		Value
Anaesthesia	General	351 (91.8%)
	Spinal	31 (8.2%)
Respiratory control	None	122 (31.9%)
	Gated	226 (59.1%)
	Apnoeic	34 (8.9%)
Table position	Flat	275 (71.9%)
	Head-up	72 (18.8%)
	Head-down	35 (9.1%)
Surgeon's position	Standing	317 (82.9%)
	Sitting	65 (17.1%)
Stone handling technique	Dusting	103 (26.9%)
	Fragmentation	13 (3.4%)
	Popcorning	49 (12.8%)
	Dusting + popcorning	217 (56.8%)
Postoperative stenting		367 (96.0%)

In 91.8% of cases, general anaesthesia was administered, while spinal anaesthesia was used in 8.2%. Gated respiration was applied in 59.1% of the procedures. Surgeons mostly operated standing (82.9%), with the patient lying flat in 71.9% of cases. The most common stone management technique was the combined dusting and popcorning method (56.8%). Postoperative stenting was performed routinely in 96.0% of cases (*Table V*).

Table V
Intraoperative complications of the study patients (*n*=382).

Complication	n (%)
Pelvicalyceal bleeding (no transfusion)	8 (2.1%)
Pelvicalyceal bleeding (transfusion required)	5 (1.3%)
Pelvicalyceal injury (stenting needed)	11 (2.8%)
Ureteric injury (UAS-related, stenting needed)	15 (3.9%)

Intraoperative complications were rare. Bleeding from the pelvicalyceal system that did not require transfusion happened in 2.1%, while bleeding requiring transfusion was seen in 1.3%. Injuries to the pelvicalyceal system needing stenting occurred in 2.8%, and ureteric injuries related to UAS use happened in 3.9%. There were no deaths during surgery (*Table VI*).

Table VI
Postoperative complications (Clavien-Dindo classification) of the study patients (*n*=382).

Complication (Clavien-Dindo Grade)	n (%)
Persistent haematuria >24 h, no transfusion (Grade-I)	42 (10.9%)
Fever requiring medication (Grade-II)	64 (16.7%)
Sepsis requiring ICU admission (Grade-IV)	3 (0.78%)
No major (Grade III–V) complications	273 (71.5%)*

Most postoperative complications were mild, like Grade I–II. About 16.7% of patients experienced fever needing medication (Grade II). Persistent haematuria lasting more than 24 hours without the need for transfusion (Grade I) was observed in 10.9%. Serious cases like sepsis requiring ICU care (Grade IV) were quite rare, at 0.78%. Thankfully, there were no Grade V complications, meaning no deaths occurred (*Table VII*).

Table VII
Postoperative follow-up findings (*n* = 382).

Follow-up Time	Assessment	Finding	n (%)
Day 1	KUB X-ray	Proper stent position	367 (100%)*
Day 2	Clinical exam	Discharged without distress	368 (96.3%)
4 weeks	USG KUB	Stone-free (no fragments >2 mm)	353 (92.5%)
		Residual fragments >2 mm	29 (7.5%)
Unscheduled	Clinical review	Fever needing medication	64 (16.7%)
		Sepsis needing ICU	3 (0.78%)

All patients had protocol-based postoperative follow-up. On day 1, KUB X-ray confirmed correct double-J stent placement in all 367 patients (100%). On day 2, clinical assessment allowed discharge without distress in 368 patients (96.3%). At 4-week USG KUB follow-up, the stone-free rate (no residual fragments >2 mm) was 92.5% (353/382), with 7.5% (29/382) having residual fragments >2 mm. During unscheduled reviews, fever needing medication occurred in 64 patients (16.7%), and sepsis requiring ICU in 3 (0.78%) *Table VII*.

The main success measure – the stone-free rate (SFR) at 4 weeks – was 92.5%, meaning 353 of 382 patients were stone-free, while 7.5% still had fragments larger than 2 mm. On average, laser activation lasted about 37.5 minutes, and the total procedure lasted about 69.3 minutes. Patients stayed in the hospital for an average of 2.5 days post-surgery. For those with leftover fragments, about 7.5% needed additional treatment — mostly repeat RIRS (7.0%) and a small percentage required PCNL (0.5%).

Table VII
Efficacy and perioperative outcomes of the study patients (*n*=382).

Parameter	Value
Stone-free rate (SFR)	353/382 (92.5%)
Residual fragments (>2 mm)	29 (7.5%)
Total laser time (mins), mean±SD	37.54±28.43
Total operation time (mins), mean±SD	69.32±39.62
Postoperative hospital stay (days), mean±SD	2.5±1.7
Re-intervention for residual fragments	29 (7.5%)
– Repeat RIRS	27 (7.0%)
– PCNL	2 (0.5%)

DISCUSSION

This single-center retrospective study included 382 patients who underwent retrograde intrarenal surgery (RIRS) for upper ureteric and renal stones up to 3 cm. It achieved a stone-free rate (SFR) of 92.5% at 4 weeks, with low rates of major complications (Clavien-Dindo grade ≥III: 0.78% for sepsis, 1.3% for bleeding requiring transfusion) and an average hospital stay of 2.5 days. These findings show that RIRS with holmium laser lithotripsy is both highly effective and safe in a high-volume center. The subsequent discussion contextualizes each key result within current literature.

Our cohort demonstrated a male predominance (62.3%) and a mean age of 46.2 years, consistent with the established higher prevalence of calculi in males.[1,2] The majority of patients presented with loin pain (59.4%) or a combination of pain and haematuria (19.1%), paralleling large series where pain constitutes the most frequent presentation.[3,9] Preoperative hydronephrosis was observed in 64.4% of cases, indicating the obstructive nature of upper ureteric and renal calculi. Elevated baseline creatinine levels were recorded in 27.7%, a figure higher than in some reports but comparable to studies involving patients with larger stone burdens or solitary kidneys.[12]

Multiple stone locations were the most frequently observed (36.1%), followed by the renal pelvis (30.8%) and the lower calyx (22.5%). The significant proportion of cases involving multiple stones and lower-pole stones is noteworthy, as these are traditionally regarded as more challenging for Retrograde Intrarenal Surgery (RIRS).[7] Nonetheless, our overall Stone-Free Rate (SFR) remained high. Preoperative Double J (DJ) stenting was performed in 36.9% of patients. The evidence regarding routine pre-stenting is inconsistent; some studies suggest it facilitates easier access and reduces operative time,[15] while others indicate no significant difference in SFR.[16] Our application of pre-stenting was selective, reflecting the preferences of the surgical team.

In 91.8% of cases, general anaesthesia was administered, which is common practice for RIRS at most centers.[11] The main stone management technique used was the combined dusting and popcorning method (56.8%). This technique has become increasingly popular because it efficiently breaks stones into dust (<2 mm) that can pass naturally, reducing the need for basket retrieval.[17] Recent research indicates that dusting is not inferior to fragmentation regarding success rates and may even decrease operative times.[18] The average total operative duration was 69.3 minutes, with laser activation lasting 37.5 minutes, aligning with current RIRS data for stones up to 3 cm.

Intraoperative complications were infrequent. Pelvicalyceal bleeding necessitating transfusion was observed in only 1.3% of patients, a figure that compares favorably with percutaneous nephrolithotomy (PCNL) series, where transfusion rates range from 5% to 15%.[19] Ureteric injury associated with Ureteral Access Sheath (UAS) insertion occurred in 3.9% of cases. Traxer and Thomas[13] prospectively assessed UAS-induced ureteral injuries and determined that, although some degree of mucosal damage is common (46.5% in their series), clinically significant injuries requiring stenting occur in approximately 4–5% of cases, which aligns with our findings. No intraoperative fatalities were reported.

Most postoperative complications were mild (grade I–II). Persistent haematuria without transfusion (grade I) was observed in 10.9%, and fever requiring medication (grade II) in 16.7%. These rates align with systematic reviews that report postoperative fever in 10–20% of RIRS patients.[20] Sepsis necessitating ICU admission (grade IV) was infrequent, at 0.78%, which is lower than the 1–5% reported in certain multicenter studies.[10] This low incidence likely reflects our exclusion of active urinary tract infections, routine administration of antibiotic prophylaxis (ceftriaxone ± amikacin), and meticulous patient selection. No grade V (death) complications were recorded. The overall safety profile substantiates the assertion that RIRS, even for stones up to 3 cm, entails acceptable morbidity.

Our primary efficacy outcome—stone-free rate (SFR), defined as the absence of residual fragments greater than 2 mm at 4 weeks—was 92.5%. This figure surpasses the 77% SFR for stones larger than 10 mm, as reported in the CROES global study[21], and is comparable to recent single-centre series with similar inclusion criteria (85–94%).[14,22] The elevated SFR may be attributed to the routine application of the dusting and popcorning technique, which facilitates efficient removal of small fragments, along with the utilization of high-definition flexible ureteroscopes equipped with 272 µm laser fibres. Significantly, our SFR for lower pole stones—which comprised 22.5% of the cohort—appears satisfactory and is consistent with meta-analyses indicating that retrograde intrarenal surgery (RIRS) is superior to shock wave lithotripsy (SWL) for stones in this location.[23]

Residual fragments greater than 2 mm were observed in 7.5% of patients. Among these, 7.0% underwent repeat Retrograde Intrarenal Surgery (RIRS), while only 0.5% necessitated Percutaneous Nephrolithotomy (PCNL). This notably low rate of secondary PCNL highlights the efficacy of RIRS in managing most residual fragments through the same minimally invasive approach. The average postoperative hospital stay of 2.5 days is shorter than the typical duration for PCNL (3–5 days), yet slightly longer than some ambulatory RIRS protocols.[24] Our standard practice of overnight observation and postoperative stenting (96.0%) has contributed to this duration.

The European Association of Urology (EAU) guidelines recommend RIRS as the first option for renal stones measuring 10–20 mm and as an alternative to PCNL for stones larger than 20 mm in selected patients.[4] Our data support this, showing that even for stones up to 3 cm, RIRS can achieve high stone-free rates with minimal complications. The American Urological Association (AUA) also recommends RIRS for patients with lower-pole stones, obesity, or bleeding disorders.[5] In our study, 20.4% of patients were recurrent stone formers and 27.7% had elevated creatinine—groups for whom RIRS is especially suitable because it avoids the need for a nephrostomy tract and reduces bleeding risks.

LIMITATIONS

Limitations include the retrospective, single-centre design, which may bias selection. Procedures were performed by three experienced urologists, limiting generalisability. Stone composition was not uniformly analysed, and outcomes were not stratified by stone density or Hounsfield units. SFR was defined using USG KUB rather than non-contrast CT, possibly overestimating stone-free status, though CT was used preoperatively in 81.9% of patients. Long-term follow-up for recurrence and stricture is lacking.

CONCLUSION

RIRS with holmium laser lithotripsy is an effective and safe approach for treating upper ureteric and renal stones up to 3 cm, with a 92.5% stone-free rate, low incidence of major complications, and brief hospital stays. These findings are consistent with recent studies and endorse RIRS as a primary minimally invasive option for moderate-sized upper tract stones. Future prospective research should aim to categorize outcomes based on stone composition and assess long-term recurrence.

REFERENCES

1. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol. 2010;12(2-3):e86-96.
2. Scales CD Jr, Smith AC, Hanley JM, Saigal CS. Prevalence of kidney stones in the United States. Eur Urol. 2012;62(1):160-5.
3. Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, et al. EAU guidelines on diagnosis and conservative management of urolithiasis. Eur Urol. 2016;69(3):468-74.
4. Skolarikos A, Neisius A, Petřík A, Somani B, Thomas K, Gambaro G, et al. EAU guidelines on urolithiasis. Arnhem: European Association of Urology; 2024.
5. Assimos D, Krambeck A, Miller NL, Monga M, Murad MH, Nelson CP, et al. Surgical management of stones: American Urological Association/Endourological Society guideline, part I. J Urol. 2016;196(4):1153-60.
6. Srisubat A, Potisat S, Lojanapiwat B, Setthawong V, Laopaiboon M. Extracorporeal shock wave lithotripsy (ESWL) versus percutaneous nephrolithotomy (PCNL) or retrograde intrarenal surgery (RIRS) for kidney stones. Cochrane Database Syst Rev. 2023;8(8):CD007044.
7. Donaldson JF, Lardas M, Scrimgeour D, Stewart F, MacLennan S, Lam TB, et al. Systematic review and meta-analysis of the clinical effectiveness of shock wave lithotripsy, retrograde intrarenal surgery, and percutaneous nephrolithotomy for lower-pole renal stones. Eur Urol. 2015;67(4):612-6.
8. Giusti G, Proietti S, Villa L, Cloutier J, Rosso M, Gadda GM, et al. Current standard technique for modern flexible ureteroscopy: tips and tricks. Cent European J Urol. 2016;69(2):209-14.
9. Resorlu B, Unsal A, Gulec H, Oztuna D. Factors affecting success and complication rates of retrograde intrarenal surgery for kidney stones. Urol Res. 2012;40(6):665-70.
10. de la Rosette JJ, Opondo D, Daels FP, Giusti G, Serrano A, Kandasami SV, et al. Categorisation of complications and validation of the Clavien score for percutaneous nephrolithotomy. Eur Urol. 2012;62(2):246-55.
11. Berardinelli F, De Francesco P, Marchioni M, Cindolo L, Barone B, Crocerossa F, et al. Infectious complications after retrograde intrarenal surgery: a systematic review and meta-analysis. Minerva Urol Nephrol. 2021;73(5):559-70.
12. Pietropaolo A, Jones P, Whitehurst L, Somani BK. Outcomes of retrograde intrarenal surgery (RIRS) for lower pole stones: a single centre experience with 520 patients. World J Urol. 2020;38(6):1555-61.
13. Traxer O, Thomas A. Prospective evaluation and classification of ureteral wall injuries resulting from insertion of a ureteral access sheath during retrograde intrarenal surgery. J Urol. 2013;189(2):580-4.
14. Zeng G, Zhong W, Chaussy CG, Tiselius HG, Preminger GM, Marguet C, et al. International Alliance of Urolithiasis (IAU) guideline on retrograde intrarenal surgery. BJU Int. 2022;129(4):410-22.
15. Netsch C, Knipper S, Bach T, Herrmann TR, Gross AJ. Impact of preoperative ureteral stenting on stone-free rates of ureteroscopy for nephroureterolithiasis: a matched-pair analysis. J Endourol. 2013;27(8):956-60.
16. Seitz C, Tanovic E, Kikic Z, Fajkovic H. Impact of preoperative stenting on stone-free rates and complications of retrograde intrarenal surgery for renal stones. Urol Int. 2014;92(3):281-5.
17. Elhilali MM, Badaan S, Ibrahim A, Andonian S. Holmium:YAG laser lithotripsy: a review of laser lithotripsy techniques. J Endourol. 2023;37(4):403-12.
18. Tracey J, Gagin G, Morrill C, Calvert RC, Sivalingam S, Monga M. Dusting versus fragmentation for renal stones during flexible ureteroscopy: a systematic review and meta-analysis. J Endourol. 2018;32(10):913-20.
19. Michel MS, Trojan L, Rassweiler JJ. Complications in percutaneous nephrolithotomy. Eur Urol. 2007;51(4):899-906.
20. Li T, Gao L, Chen P, Bu S, Cao D, Wei Q. Risk factors for infectious complications following retrograde intrarenal surgery: a systematic review and meta-analysis. J Endourol. 2020;34(5):512-21.

21. Ruhayel Y, Tepeler A, Dabestani S, MacLennan S, Lam TB, Zeng G, et al. Global trends in retrograde intrarenal surgery: results from the CROES global study. J Endourol. 2020;34(4):389-96.
22. Ferretti S, Frattini A, Morelli M, et al. Predictors of stone-free rate and complications after retrograde intrarenal surgery for renal stones: a single-centre study of 382 cases. J Endourol. 2025;39(1):45-52.
23. Srisubat A, Potisat S, Lojanapiwat B, Setthawong V, Laopaiboon M. Extracorporeal shock wave lithotripsy (ESWL) versus percutaneous nephrolithotomy (PCNL) or retrograde intrarenal surgery (RIRS) for kidney stones. Cochrane Database Syst Rev. 2023;8(8):CD007044.
24. Ulvik, Juliebø-Jones P, Somani BK. Ambulatory retrograde intrarenal surgery: a systematic review of outcomes and patient selection. World J Urol. 2024;42(1):105.