

Original Research Article

Effectiveness of retrograde intrarenal surgery for upper ureteric and renal stones: a retrospective cohort study

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ABSTRACT

Background: Retrograde intrarenal surgery (RIRS) has become an increasingly preferred minimally invasive procedure for the management of upper ureteric and renal stones due to its favorable safety profile and high stone clearance rate. This study aimed to evaluate the effectiveness and perioperative outcomes of RIRS in patients with upper urinary tract calculi.

Methods: This retrospective cohort study was conducted at the Department of Urology, Enam Medical College and Hospital, from July 2018 to January 2026. A total of 382 adult patients with upper ureteric or renal stones who underwent RIRS with holmium laser lithotripsy were included. Demographic characteristics, stone-related variables, intraoperative findings and postoperative outcomes were retrieved from hospital records and analyzed descriptively.

Results: The mean age of the patients was 46.2±14.8 years and the mean BMI was 26.3±4.6 kg/m². Multiple-site stones were the most common (36.1%), followed by renal pelvic stones (30.8%). Preoperative DJ stenting was performed in 36.9% of patients. General anesthesia was used in 91.8% of procedures and the combined dusting and popcorning technique was the most frequently applied stone management method (56.8%). The stone-free rate (SFR) at 4 weeks was 92.5%. Mean laser activation and operative times were 37.5 and 69.3 minutes, respectively. The average postoperative hospital stay was 2.5 days, while 7.5% of patients required additional intervention.

Conclusions: RIRS is an effective and safe minimally invasive treatment option for upper ureteric and renal stones, providing high SFRs with acceptable perioperative outcomes.

Keywords: Retrograde intrarenal surgery, Renal stone, Upper ureteric stone, Holmium laser lithotripsy, Stone-free rate

INTRODUCTION

Urolithiasis is a common urological disorder affecting a significant proportion of the global population and is associated with considerable morbidity, recurrence and healthcare burden.¹ The prevalence of upper ureteric and renal calculi has increased over recent decades due to changes in dietary habits, sedentary lifestyle, obesity and metabolic disorders.² Patients commonly present with flank pain, hematuria, urinary tract infection, or

obstructive uropathy, which may adversely affect renal function and quality of life if left untreated.³

Management of upper urinary tract stones has evolved substantially with advances in endourological techniques and laser technology.⁴ Treatment options for upper ureteric and renal stones include extracorporeal shock wave lithotripsy (ESWL), ureteroscopy, RIRS and percutaneous nephrolithotomy (PCNL).⁵ The choice of treatment depends on multiple factors such as stone size,

location, composition, patient anatomy, comorbidities and surgeon expertise.⁶ Although PCNL remains the standard treatment for large renal stones, it is associated with increased morbidity, bleeding risk and longer hospital stay.⁷ ESWL, while noninvasive, often demonstrates lower SFRs and may require repeated sessions, particularly for larger or harder stones.²

RIRS has emerged as a minimally invasive and effective alternative for the management of upper ureteric and renal calculi, especially stones measuring less than 3 cm.⁸ The development of flexible ureteroscopes, improved optics, ureteral access sheaths and holmium laser lithotripsy has significantly enhanced the safety and efficacy of this procedure. RIRS offers several advantages, including reduced postoperative pain, shorter hospital stay, lower complication rates and faster recovery compared with more invasive procedures.⁹ Furthermore, it can be safely performed in patients who are poor candidates for PCNL or ESWL.

Despite increasing utilization of RIRS worldwide, treatment outcomes may vary depending on stone burden, anatomical factors, surgical expertise and perioperative management¹⁰. Evaluation of institutional experiences is therefore important to assess procedural effectiveness, complication profiles and perioperative outcomes in real-world clinical settings.¹¹ Limited local data are available regarding the effectiveness of RIRS in patients with upper ureteric and renal stones.¹²

Therefore, this retrospective cohort study was conducted to evaluate the effectiveness and perioperative outcomes of RIRS for upper ureteric and renal stones at a tertiary care hospital. The study aimed to assess SFRs, operative characteristics, complications, hospital stay and the need for re-intervention following RIRS.

METHODS

This retrospective cohort study was conducted at the Department of Urology, Enam Medical College & Hospital, from July 2018 to January 2026. A total of 382 adult patients with upper ureteric or renal stones who underwent RIRS with holmium laser lithotripsy were included. The procedures were performed by three experienced consultant urologists. Ethical approval was obtained from the institutional ethics committee of Enam Medical College and Hospital in accordance with the Declaration of Helsinki (2013 revision). All patient information was anonymized before analysis. Written informed consent was obtained prior to surgery and the requirement for separate consent for retrospective chart review was waived.

Patients aged ≥ 18 years of either gender with symptomatic upper ureteric or renal calculi measuring up to 3 cm confirmed by imaging were included. Patients with active urinary tract infection, pregnancy, or severe

anatomical obstruction preventing safe ureteroscope passage were excluded.

Baseline demographic and clinical data, stone characteristics, intraoperative findings and postoperative outcomes were retrieved from hospital records. Variables included age, gender, BMI, stone laterality, stone location, preoperative hydronephrosis, preoperative DJ stenting, operative time, laser activation time, stone handling technique and perioperative outcomes.

All procedures were performed under general or spinal anesthesia in the lithotomy position. Following cystoscopy and guidewire placement, a 10-12 Fr ureteral access sheath was advanced when feasible. Stones were fragmented using a holmium laser with a 272 μ m fiber at settings of 1.0-1.5 J and 8-10 Hz. Fragments >2 mm were extracted with a basket, while smaller fragments were left for spontaneous passage. Postoperative follow-up included KUB X-ray and ultrasonography at 4 weeks.

Primary outcome was SFR, defined as residual fragments ≤ 2 mm on postoperative imaging. Secondary outcomes included operative time, hospital stay, perioperative complications and re-intervention rates. Data were analyzed using descriptive statistics with IBM SPSS.

RESULTS

Table 1 found 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. Average BMI=26.3 \pm 4.6 kg/m². Left-sided stones were most common, occurring in 37.1% of cases, while bilateral procedures performed in 29.1% of patients. Recurrent stone formers made up 20.4% of study population.

Table 1: Demographic characteristics of the study patients, (n=382).

Parameters	Value	
Age (in years), mean \pm SD	46.2 \pm 14.8	
BMI (kg/m ²), mean \pm SD	26.3 \pm 4.6	
Surgical side	Right	129 (33.7%)
	Left	142 (37.1%)
	Bilateral	111 (29.1%)
Recurrent stone former	78 (20.4%)	

Table 2: Stone location and pre-operative stenting of the study patients, (n=382).

Parameters	Value (%)	
Stone location	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)

Table 2 shows 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 3: Intraoperative characteristics of the study patients, (n=382).

Parameters		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 Table 3 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 4: Efficacy and perioperative outcomes of the study patients, (n=382).

Parameters	Value
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%)

Table 4 shows the main success measure-the 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%).

DISCUSSION

The present retrospective cohort study evaluated the effectiveness and perioperative outcomes of RIRS in 382 patients with upper ureteric and renal stones. The findings demonstrated a high SFR of 92.5% at 4 weeks, along with acceptable operative time, short hospital stay and low requirement for secondary intervention, indicating that RIRS is an effective and safe minimally invasive treatment option.

In this study, the mean age of the patients was 46.2±14.8 years, with the majority belonging to the 35-55 years age group. Similar age distributions have been reported in previous studies evaluating RIRS outcomes. Venkatachalapathy et al observed that renal stone disease predominantly affected middle-aged adults, which is consistent with our findings.¹³ Likewise, Gauhar et al in the FLEXOR multicenter registry involving 6669 patients, reported comparable demographic characteristics among patients undergoing RIRS.¹⁴

Our study found that stones were most commonly located at multiple sites (36.1%) and in the renal pelvis (30.8%). The increasing use of RIRS for complex and multi-site calculi has also been documented by Nebioğlu et al who analyzed 3,781 RIRS procedures and demonstrated favorable outcomes even in patients with varying stone burdens and locations.¹⁵ The current study also observed preoperative DJ stenting in 36.9% of patients. Similar practices have been discussed by Ansari et al and Assantachai et al who reported that pre-stenting may facilitate ureteral access sheath placement and improve procedural success in selected patients.^{16,17}

General anesthesia was used in 91.8% of procedures in our series, while spinal anesthesia was utilized in a smaller proportion. This preference is supported by Ho et al whose meta-analysis concluded that general anesthesia remains the most commonly preferred anesthetic technique during RIRS because it offers better respiratory control and patient immobility during laser lithotripsy.¹⁸ In the present study, gated respiration was used in 59.1% of cases, which may have contributed to procedural precision and reduced stone migration.

The combined dusting and popcorning technique was the most frequently applied stone disintegration method (56.8%). Recent advancements in holmium laser technology have increased the popularity of dusting techniques due to reduced need for fragment extraction and shorter operative time. Qin et al similarly demonstrated that modern RIRS with holmium laser lithotripsy provides excellent clinical efficacy with minimal renal functional impairment.¹⁹

The most important finding of our study was the high SFR of 92.5%. This result is comparable to those reported in recent international studies. Venkatachalapathy et al reported high clearance rates following RIRS across varying stone sizes, while Chen et al found comparable stone-free outcomes between RIRS and PCNL for selected renal stones.^{13,20} Naeem et al in a recent meta-analysis, also concluded that RIRS offers excellent stone clearance with a favorable complication profile compared with PCNL in appropriately selected patients.²¹

The mean operative time in our study was 69.3 minutes and the average laser activation time was 37.5 minutes, which are consistent with previously published reports. Datta et al and Fauzi et al similarly documented operative durations ranging between 60 and 90 minutes during RIRS procedures for renal calculi.^{22,23}

The average postoperative hospital stay in our study was only 2.5 days, supporting the minimally invasive nature of RIRS and its advantage of early postoperative recovery.

Residual fragments requiring re-intervention were observed in 7.5% of patients, with repeat RIRS performed in most cases and PCNL required in only 0.5%. Similar low secondary intervention rates have been documented by Giulioni et al and Gauhar et al who emphasized the overall safety and effectiveness of RIRS in large multicenter cohorts.^{14,24}

Additionally, Lin et al and Doğan highlighted the beneficial role of ureteral access sheath use in improving visualization, reducing intrarenal pressure and facilitating repeated instrument passage during RIRS.^{25,26}

Limitations

It was a retrospective single-center study, which may limit the generalizability of the findings to other institutions. In addition, long-term follow-up data regarding stone recurrence and delayed complications were not available for all patients.

CONCLUSION

RIRS is an effective and minimally invasive treatment option for upper ureteric and renal stones, demonstrating a high SFR with acceptable operative time, short hospital stay and low re-intervention rates. The findings of this study support the safety and efficacy of RIRS as a reliable management approach for appropriately selected patients with upper urinary tract calculi.

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