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Original Research Article

Clinical Outcomes of Flexible Ureterorenoscopy in the Treatment of Renal and Upper Ureteric Stones Less Than 2 cm: A Retrospective Tertiary Centre Study

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Conflict of interest: Nil

Abstract:

Background: Flexible Ureterorenoscopy (RIRS) has emerged as a minimally invasive and effective treatment for renal and upper ureteric stones, particularly those <2 cm. Technological advancements in endoscopic equipment have widened its indications.

Objective: To evaluate the efficacy and safety of RIRS for the treatment of renal and ureteric calculi <2 cm.

Methods: This retrospective observational study was conducted at a tertiary care centre over a period of 36 months. Medical records of 63 patients with renal/upper ureteric calculi <2 cm who underwent RIRS using flexible Ureterorenoscopy and Holmium: YAG laser were reviewed. Outcomes assessed included stone-free rate (SFR), complications (Clavien-Dindo classification), operative time, pain score, hospital stay, and return to routine activity.

Results: The mean age was 41.4 ± 9.9 years, with 54% males. Most stones (65.1%) measured 1.5–2 cm. The overall SFR was 74.6% after a single procedure. The highest stone-free rate was observed for upper calyceal stones (100%) and ureteric calculi (90%). Complications were noted in 23.8% of patients, predominantly minor (Clavien Grade I or II). Mean operative time was 44.5 ± 7.2 minutes, and average hospital stay was 2.3 days. No major intraoperative or postoperative complications were recorded.

Conclusion: RIRS is a safe and effective treatment modality for renal and ureteric stones <2 cm, demonstrating high success rates with minimal morbidity in real-world clinical practice.

Keywords: Flexible Ureterorenoscopy, Retrospective study, Renal calculi, Ureteric calculi.

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Introduction

Nephrolithiasis is a prevalent urological condition, most commonly affecting individuals in their third to fourth decades [1]. Its incidence varies geographically and affects all age groups with no clear gender predominance. The global rise in cases is attributed to lifestyle and dietary changes, such as increased salt intake and reduced hydration. The lifetime risk is estimated at 13% in men and 7% in women [2]. Traditionally, extracorporeal shock wave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL) have been employed for the treatment of upper urinary tract stones depending on stone size, location, and composition [3]. Flexible Ureterorenoscopy (RIRS) has emerged as a safe and effective alternative for managing renal and ureteric calculi, particularly those less than 2 cm in diameter. With the development of high-definition digital ureteroscopes, improved deflection mechanisms, and efficient laser lithotripsy systems, RIRS has demonstrated favourable stone-free rates and low complication profiles [4]. Furthermore, RIRS offers advantages including access to all calyceal groups, reduced morbidity, and suitability for anatomically complex kidneys or patients unfit for PCNL [5]. Current guidelines from the American Urological Association and European Association of Urology

recognize RIRS as a first-line treatment option for renal stones <2 cm and ureteric calculi, particularly when ESWL is contraindicated or has failed [6,7]. Despite these advancements, there remains variability in outcomes based on stone location, number, and intraoperative parameters, highlighting the need for real-world data on its effectiveness and safety, in this context, the present retrospective study was undertaken to assess the safety and efficacy of flexible Ureterorenoscopy in the management of renal and upper ureteric calculi less than 2 cm, with emphasis on operative time, stone clearance, and complication rates.

Study design: A retrospective observational study.

Study setting: This study was conducted in the Department of Genitourinary Surgery at KIMS Hospital, a tertiary care centre in Secunderabad.

Study period: Medical records from June 2022 to June 2025were reviewed.

Study population: Adult patients with renal or ureteric stones <20 mm who underwent RIRS and had complete medical records with follow-up data were included.

Ethical Clearence: Ethical approval for the study was obtained from the Institutional Ethics Committee, and the requirement for informed consent was waived due to the retrospective nature of the study involving anonymized patient data.

Inclusion criteria:

- Patients diagnosed with renal calculi <2 cm who underwent RIRS during the study period
- Hemodynamically stable patients with complete clinical records
- Patients with documented follow-up data

Exclusion Criteria:

- Incomplete or missing medical records
- Serum creatinine >451 μmol/L
- UPJO, pregnancy, cardiopulmonary insufficiency
- Active urinary tract infection at the time of surgery

Sample size: Based on a previous similar study by Jain R et al [8], the proportion used for sample size estimation was 79.6%, With a 5% level of significance ($\alpha = 0.05$), the corresponding Z value is 1.96. Using the formula n=(Z_(α/2)/d) 2^ "p(1-p)", where d is the minimum clinically significant difference (10%), the calculated sample size required for the study is 63.

Methodology: Data were collected retrospectively from hospital medical records, operative notes, and follow-up registers. Preoperative evaluation included CT scan with stone protocol documenting stone size, number, and location.

Operative details such as type of ureteroscope, use of ureteral access sheath, laser settings, and intraoperative findings were retrieved from surgical records.

Postoperative outcomes including stone-free rate (SFR), complications (graded using Modified Clavien-Dindo classification), operative time, and hospital stay were documented.

Follow-up data at 4 weeks and up to 3 months were reviewed to assess residual stones and need for additional procedures. SFR was defined as no stones or residual fragments ≤4 mm as per EAU guidelines.

Statistical Analysis: All statistical analysis was done by using MS Excel 2010 and SPSS software Version 21.0. Descriptive data was presented as mean ± standard deviation and Percentages. Data was tabulated and graphically represented. Chi-square test was performed to assess the association among various categorical variables. For all statistical analysis, P-value of < 0.05 was considered statistically significant.

Clavien score	Complication-management definitions
None	Normal postoperative course; non-opioid analgesia only.
Grade 1	Minor complications managed conservatively: opioid analgesia, symptomatic PONV, low-grade fever, IV fluids for renal function or bleeding, stent-related symptoms, ureteric clot, or urinary retention.
Grade 2	Requires pharmacological treatment: blood transfusion, antibiotics (for UTI, fever, pneumonia), oxygen, diuretics, antiarrhythmics, or ward-based management for heart failure or atelectasis.
Grade 3A	Intervention **without** general anaesthesia: endoscopic haemostasis, ureteric stenting, nephrostomy-related procedures, drainage of urine or abscess, stent repositioning.
Grade 3B	Intervention **under** general anaesthesia: angioembolization, nephrectomy, balloon dilation, ureteral repair, or open abscess drainage.
Grade 4A	Life-threatening complications requiring ICU care: hypovolemic shock, ARDS, acute renal failure, heart failure, severe hypoxia, or arrhythmias.
Grade 4B	Multiorgan failure due to urosepsis requiring ICU management.
Grade 5	Death due to complication.

Results

This study included a total of 63 patients with 34 (54 %) being male and 29 (46%) females, and the mean age was found as 41.4±9.9 years. The stones were categorized into three size groups: 14.3% measured less than 1 cm, 20.6% were between 1 and 1.5 cm, and the majority, 65.1%, measured between 1.5 and 2 cm. Stone locations were divided into four groups: 17.5% in the upper calyx, 36.5% in the middle calyx, 46% in the lower calyx, and 31.7% in the renal pelvis or upper ureter. The stone-free rate was significantly influenced by stone location ($p = 0.03$; $\chi^2 = 8.78$), with the highest clearance in the upper calyx (100%), followed by renal pelvis/ureter (90%), lower calyx (75.9%), and middle calyx (60.8%). Residual fragments were most frequent in the middle calyx. The operative time ranges between 30 to 75 minutes, with an average of 44.52 ± 7.52 minutes. The efficacy of the procedure was assessed by the stone-free rate after a single session, which was 74.6%, with a residual stone rate of 24.4% (n = 63) SFR was more with Calculi size < 1cm and > 1.5 to 2cms and the difference was not found to be statistically significant. The overall complication rate was 23.8%, with all events being minor and observed in 15 of 63 patients. According to the modified Clavien-Dindo classification, six were grade I, eight were grade II, and one was grade IIIA. No complications above grade IIIA were reported and mean Hospital stay was reported to be 2.3 ± 0.5 days.

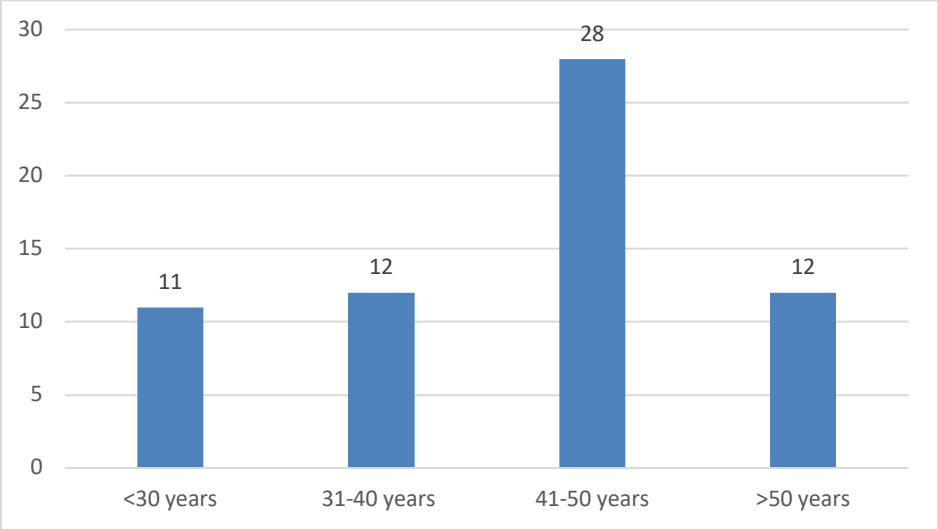

Figure I: Distribution of study subjects according to Age Groups

Table 1: Distribution of study subjects according to Stone size and Stone free rate

Stone Size	Stone Free	Residue	Total	P Value
< 1 cm	7 (77.8)	2 (22.8)	9 (100)	0.15
1 to 1.5 cms	7 (53.8)	6 (46.2)	-46.2	
> 1.5 to 2 cm	33 (80.5)	8 (19.5)	41 (100)	

Chi-square value: 3.75

Table 2: Distribution of study subjects According to Position of Calculi and stone free rate

		Stone Free Rate	Residue	Total	P value
Position of stone	Renal Pelvis/Uretric calculi	18 (90)	29(10)	20 (100)	**0.03**
	Upper Calyx	11(100)	0(0)	11 (100)	
	Middle calyx	14 (60.8)	9 (39.2)	23 (100)	
	lower calyx	22 (75.9)	7 (24.1)	29 (100)	
Chi-square value: 8.78					

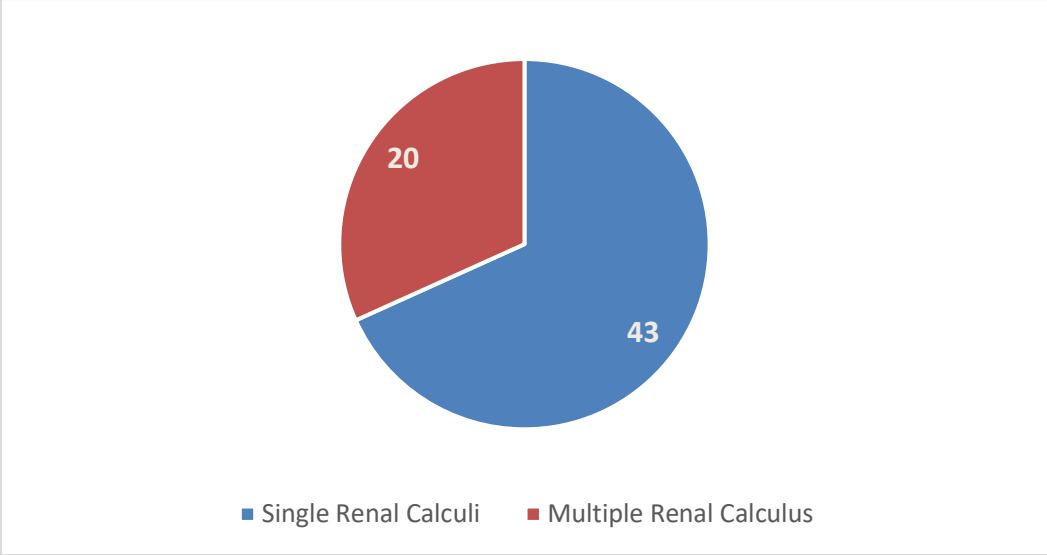

Figure II: Distribution of Study subjects according to Number of Renal Calculus (n= 63)

Table:1 Distribution of study subjects according to Postoperative Complications (Modified Clavien-Dindo Classification)

Grade of Complication	Number of Patients (n = 63)	Percentage (%)
Grade I – LUTS (Managed with observation)	4	6.4
Grade I – Vomiting (Managed with antiemetics)	2	3.2
Grade II – Fever (Required change in antibiotics)	8	12.7
Grade III B – DJ stent migration (Required restenting)	1	1.6
None	48	76.2
Total	**63**	**100**

Discussion

This retrospective study evaluated the safety and efficacy of flexible Ureterorenoscopy (FURS) for renal and upper ureteric calculi <2 cm among 63 patients, reporting a stone-free rate (SFR) of 74.6% and a residual stone rate (RSR) of 25.4%. These findings are consistent with previous studies, including those by Francesco et al [9]. (74%), De S et al [10]. (74%), and Jain R et al. [8] (76%).

Higher SFRs reported by Omar et al [11]. (88%), Breda and Angerri et al [12]. (89.3%), and Bing Yang et al [13] (85%) may reflect differences in stone characteristics, patient selection, or surgical technique. In contrast, lower rates observed by Portis et al [14]. (54%) and Christopher Chee Kong Ho et al [15]. (61%) could be due to more complex cases or variability in defining "stone-free" status.

The observed residual rate is within the reported range (10.7%–46%) and may be influenced by factors such as calyceal anatomy, stone multiplicity, and imaging methods.

Overall, FURS proves to be a safe, minimally invasive, and effective option for managing stones <2 cm. Variability across studies highlights the need for standard outcome definitions and continued technological advancements. Further multicentre studies are needed to assess long-term efficacy, recurrence, and cost-effectiveness.

Regarding safety, according to the EAU guidelines on urolithiasis, the 30-day complication rate for ureteroscopy ranges from 9% to 25% [16], though these figures are primarily derived from studies on semi-rigid ureteroscopy. Data specific to flexible Ureterorenoscopy (RIRS) remain limited. A recent meta-analysis [17], including two randomized and eight non-randomized studies, reported an overall RIRS complication rate of 10.4%, though interpretation was limited by inconsistent reporting of key clinical details such as sepsis definitions, antibiotic usage, and ureteral injury classification.

In our study, the overall complication rate was 23.8%, slightly higher than the average reported in similar RIRS studies. However, all complications were minor, with no events exceeding Clavien Grade IIIA. According to the modified Clavien-Dindo classification, six patients experienced Grade I complications, eight had Grade II, and one had a Grade IIIA complication. No major ureteral injuries occurred.

Minor ureteral wall injuries were observed in 11 patients (17.4%) and were successfully managed with short-term stenting. Two patients were re-admitted for non-obstructive pyelonephritis and

treated conservatively. One patient developed obstructive pyelonephritis due to stent migration, requiring re-stenting.

These findings are consistent with previous literature, where RIRS-related complications ranged from 0% to 25% and were generally lower than those associated with PCNL (OR 1.61; 95% CI 1.11–2.35; $p<0.01$). Commonly reported complications include fever (2%–28%), extended antibiotic use (4%–5%), and sepsis (3%–5%), while bleeding, ureteral injury, and steinstrasse are less frequent (<5%). Overall, RIRS demonstrated a favourable safety profile in our cohort, with no major complications and all adverse events managed effectively.

Conclusion

This retrospective analysis demonstrates that retrograde intrarenal surgery (RIRS) is a safe and effective treatment option for renal and upper ureteric stones measuring less than 2 cm. The procedure achieved a satisfactory stone-free rate with minimal complications, most of which were minor and manageable. These findings support the role of RIRS as a reliable minimally invasive modality in routine clinical practice.

Limitations

- Retrospective design with inherent risk of selection bias
- Single-centre study limiting generalizability
- Relatively small sample size
- Lack of long-term follow-up data

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