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ORIGINAL RESEARCH

Evaluation of factors associated with postoperative pain after retrograde intrarenal surgery for kidney stones: A prospective study

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ABSTRACT

Background: Postoperative pain following retrograde intrarenal surgery (RIRS) for kidney stones is a multifactorial clinical challenge. Identifying patient-, stone-, and operation-related predictors is essential for preoperative risk stratification and optimal pain management. This single-center prospective study investigated the correlation between various factors and postoperative pain severity in patients undergoing RIRS at Fortis Hospital, Mohali. **Methods:** Ninety-seven patients aged 18–65 years with radiologically confirmed renal stones undergoing RIRS were prospectively enrolled between March 2021 and September 2022. Preoperative demographic and clinical data (including NCCT KUB findings, stone characteristics, preoperative DJ stenting status, and hydronephrosis) were recorded. All patients underwent RIRS with a 7.5 Fr flexible digital ureteroscope and Holmium:YAG laser lithotripsy; a ureteral access sheath was used routinely. Postoperative pain was measured using the visual analogue scale (VAS) at the 6th, 12th, and 24th hour. Patients were divided into two groups: Group I (VAS <7) and Group II (VAS ≥7), with additional analgesia provided as needed. Data were statistically analyzed using IBM SPSS version 25, with a significance level of $p < 0.05$. **Results:** Out of 97 subjects, 82 patients (84.5%) had VAS scores <7, and 15 patients (15.5%) reported VAS scores ≥7. Demographic parameters, stone number, location, size, and preoperative hydronephrosis did not show significant differences between the groups ($p > 0.05$). However, a statistically significant association was identified between the size of the ureteral access sheath and the indwelling time with higher postoperative VAS scores ($p = 0.027$ and $p = 0.043$, respectively). The study findings underscore that prolonged sheath indwelling time and use of smaller-diameter sheaths are potential independent predictors of postoperative pain. **Conclusion:** Our data suggest that while many preoperative factors are comparable between patients with low and high postoperative pain, operation-related technical variables significantly influence pain outcomes post-RIRS. Preoperative identification of patients at high risk for severe pain may guide individualized intraoperative strategies and postoperative analgesia protocols.

Keywords: Retrograde intrarenal surgery, postoperative pain, kidney stones, ureteral access sheath, indwelling time, visual analogue scale.

INTRODUCTION

Retrograde intrarenal surgery (RIRS) has become an increasingly popular minimally invasive procedure for the treatment of renal calculi, offering improved stone clearance rates with reduced morbidity compared to traditional open or percutaneous interventions [1]. Despite its minimally invasive nature, postoperative pain remains a significant concern that may affect patient recovery and satisfaction [2]. Several factors, ranging from the patient's baseline characteristics to surgical technique and equipment used, are suspected to influence postoperative discomfort following RIRS.

Pain after RIRS is multifactorial in origin. Patient-related factors such as age, gender, and renal anomalies can potentially impact pain perception [3]. Stone-related factors including size, location, density, and number may also modulate postoperative outcomes [4]. Additionally, operation-related factors—including the use of the ureteral access sheath, its size, the duration for which it remains indwelling, and the need for ureteral stenting—can affect the degree of ureteral irritation, which in turn may result in increased pain scores [5]. Understanding these relationships is crucial, as it could allow clinicians to modify surgical techniques or implement

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more rigorous pain management protocols in high-risk patients [6].

The present study aims to evaluate these variables in a prospective single-center setting at Fortis Hospital, Mohali. Prior studies have examined individual factors such as stone burden or the influence of ureteral stenting; however, few have concurrently assessed multiple predictors in a systematic fashion [7]. Our study is designed to fill this gap in the literature by prospectively analyzing patient-, stone-, and operation-related factors to preoperatively identify patients who are more likely to experience severe postoperative pain following RIRS. In doing so, we hope to contribute evidence that may lead to modifications in surgical protocol, such as choosing optimal sheath dimensions and minimizing sheath indwelling time, thereby enhancing postoperative comfort and recovery.

Recent advancements in flexible digital ureteroscopes and holmium laser technology have improved the efficiency of stone fragmentation, yet technical nuances remain that can influence pain outcomes [8]. As surgical teams continue to refine operative techniques, having clear, data-driven guidelines on pain predictors is essential. This study, therefore, not only assesses the significance of these predictors but also discusses potential intraoperative adjustments that can be made to minimize pain.

MATERIALS AND METHODS

Study Design: This single-center prospective study was conducted at the Department of Urology, Fortis Hospital, Mohali, Punjab, involving 97 patients diagnosed radiologically with kidney stones.

Study Period: The study spanned over 18 months, from March 2021 to September 2022.

Study Setting: The research was undertaken within the Department of Urology at Fortis Hospital, located in Mohali, Punjab.

Ethical Considerations: Approval was granted by the Institutional Ethical Committee following a detailed presentation of the study's aim and objectives. A patient information sheet was disseminated, and written informed consent was secured from each participant, affirming their voluntary and deliberate involvement.

Study Population: Patients diagnosed radiologically with kidney stones during the study period and meeting the following criteria were included.

Inclusion Criteria

- Patients aged 18-65 diagnosed with renal stones undergoing Retrograde Intra-Renal Surgery (RIRS).
- Willingness to participate in the study.

Exclusion Criteria

- Patients with diabetes or diabetic nephropathy.
- Patients undergoing RIRS without a ureteral access sheath.
- Patients with concomitant ureteral stones undergoing endoscopic treatment in the same session.
- Patients on medication affecting pain perception.
- Patients with urinary tract infections.

Methodology

Demographic data, clinical presentation, and pre-operative findings from Non-Contrast Computed Tomography of the Kidney, Ureter, and Bladder (NCCT KUB) were collected. Patient characteristics recorded included the number, side, size, opacity of the stones, history of shock wave lithotripsy (SWL), and pre/postoperative placement of ureteral J-stents. Additional evaluations included preoperative hydronephrosis, ureteral injury, postoperative macroscopic bleeding, fever, stone-free rates, and renal anomalies such as horseshoe kidney, ectopic/pelvic kidney, and malrotated kidney. Details such as size of the access sheath, duration of surgery, and intraureteral sheath dwell time were also documented.

All procedures were performed using a 7.5 Fr flexible digital disposable ureteroscope (INDOSCOPE SLEEK, Bioredmedisys, length 670mm) under general anesthesia. A Holmium: YAG laser facilitated the fragmentation of stones until they were small enough for spontaneous passage. A ureteral access sheath (Cook) was routinely employed, and postoperative stenting was conducted using a double J stent (6 fr, 26 cm, both open ends, Cook), verified by fluoroscopy. Postoperative management included overnight Foley catheter placement and the use of anticholinergic medications to alleviate symptoms related to the stent and catheter. Intraoperative analgesia was provided by the anesthesia team using paracetamol.

Postoperative pain was assessed upon patient transfer to the ward, with evaluations conducted at 6, 12, and 24 hours post-surgery using a visual analogue scale (VAS). Patients with a VAS score ≥ 7 indicating severe pain required additional analgesics and were classified into Group I, while those with VAS scores <7 were categorized into Group II, indicating insignificant pain.

Follow-up and Outcome Assessment: Procedural success was evaluated 21 days post-surgery using X-ray and Ultrasonography of the Kidney, Ureter, and Bladder (KUB). Low Dose CT was employed for patients with non-opaque stones or residual fragments to minimize radiation exposure. Success was defined as residual fragments smaller than 3 mm or complete stone-free status.

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Statistical Analysis: Data analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY). Categorical data were presented as frequencies and percentages. Inferential statistics, including Chi-square and Fisher exact tests, were used to examine associations between variables. A p-value <0.05 was considered indicative of statistical significance.

RESULTS

This study enrolled 97 patients undergoing ureteroscopic stone removal. Patients were divided into two groups based on their postoperative visual analog scale (VAS) scores for pain: Group I (VAS < 7, n=82, 84.5%) and Group II (VAS ≥ 7, n=15, 15.5%). The demographic distribution across the groups highlighted a higher percentage of males in Group I (74.4%) compared to Group II, where the distribution was more balanced between genders (46.7% males and 53.3% females). This difference, however, did not reach statistical significance (p=0.124) as shown in Table 1 and illustrated in Figure 1.

In terms of stone characteristics—number, location, and size—Tables 2 through 5 and Figures 2 through 5 detail these variables. The analysis showed no significant differences in stone number, location, or size between the groups (all p > 0.05), indicating that these factors did not influence the severity of postoperative pain as defined by VAS scores. Specifically, the distribution of stone location across the upper and middle poles, pelvis, and lower pole did not vary significantly between the groups (p=0.942).

The ureteral access sheath characteristics, another focal point of the study, showed notable differences. Group I predominantly used a larger sheath size (10.7FR/45CM used in 70.7% of cases), whereas smaller sheath sizes were more common in Group II, contributing to higher VAS scores. The size of the ureteral access sheath was significantly associated with higher postoperative pain (p=0.027), as detailed in Table 5 and Figure 6. Similarly, prolonged sheath indwelling times, especially those exceeding 60 minutes, were linked to higher VAS scores (p=0.043) as shown in Table 6 and Figure 7.

In summary, while stone characteristics did not significantly affect postoperative pain levels, the size and indwelling time of the ureteral access sheath were critical factors influencing patient discomfort post-procedure. These findings suggest a potential area for procedural improvements to mitigate postoperative pain in patients undergoing ureteroscopic stone removal.

TABLE 1. DISTRIBUTION OF GENDER BETWEEN THE TWO GROUPS BASED ON GENDER

Groups / Gender	Group I Postop pain- (VAS <7)		Group II in Postop pa (VAS>7)		Total	P value
	N	%	N	%	N(%)	0.124
Male	61	74.4	7	46.7	68(70.1)	
Female	21	25.6	8	53.3	29(29.9)	
Total	82	100.0	15	100.0	97(100.0)	

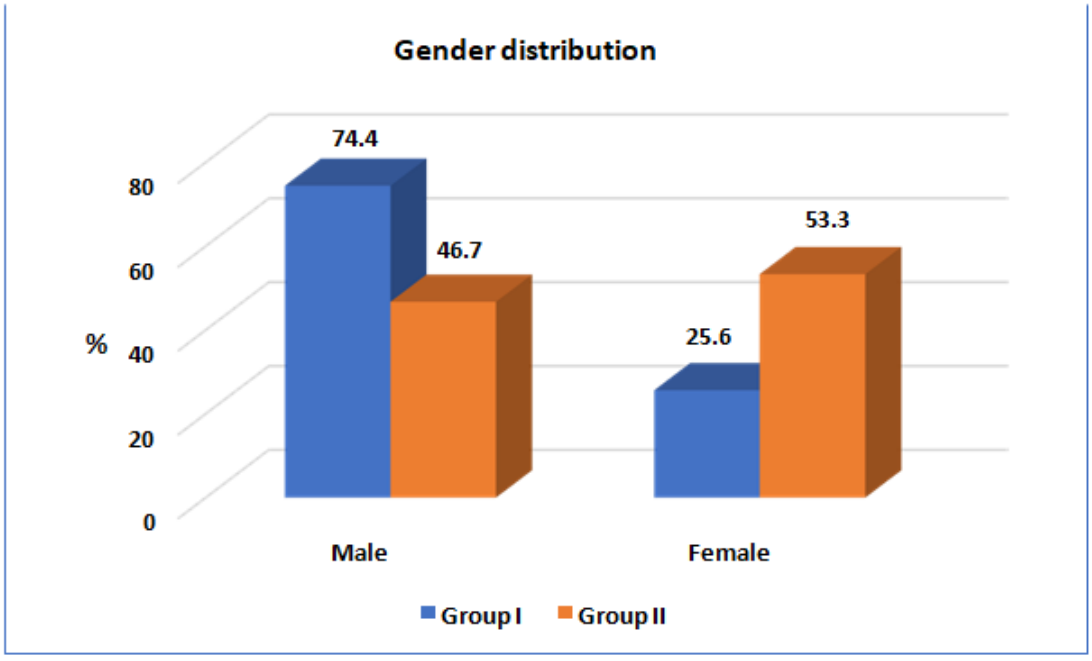

FIGURE 1. DISTRIBUTION OF GENDER BETWEEN THE TWO GROUPS BASED ON GENDER

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TABLE 2. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE SIDE INVOLVED

Groups / Sides	Group I Postop pain- (VAS <7)		Group II Postop pain- (VAS>7)		Total	P value
	N	%	N	%	N(%)	1.00
Left	41	50.0	7	46.7	48(49.5)	
Right	41	50.0	8	53.3	49(50.5)	
Total	82	100.0	15	100.0	97(100.0)	

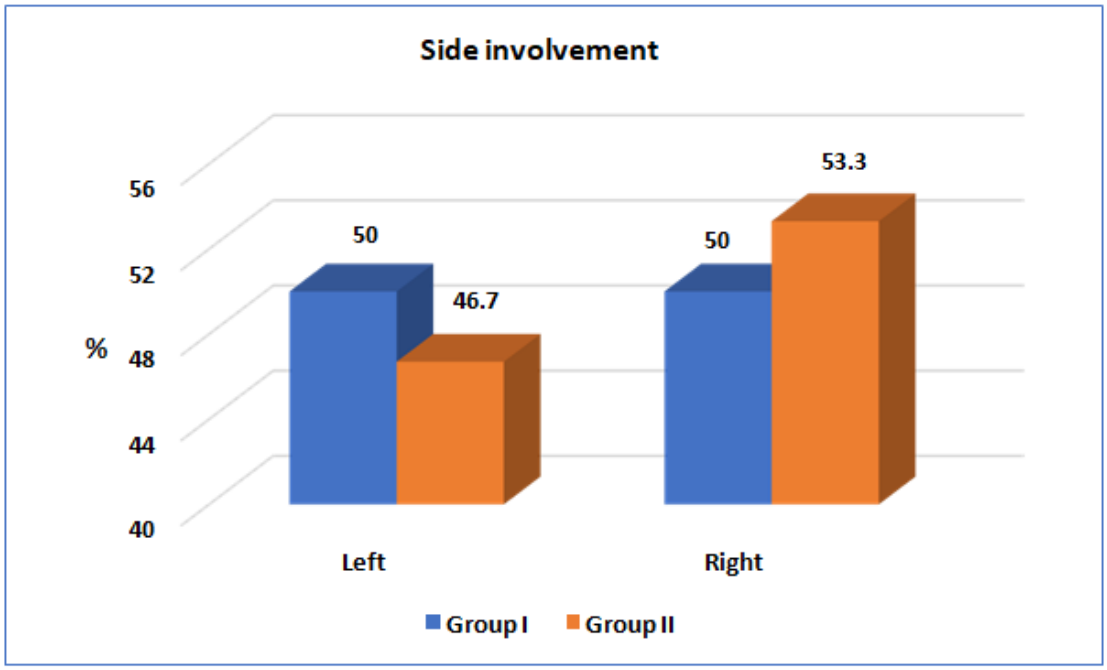

FIGURE 2. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE SIDE INVOLVED

TABLE 3. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE NUMBER OF STONES

Groups / No. of stones	Group I Postop pain- (VAS <7)		Group II Postop pain (VAS>7)		Total	P value
	N	%	N	%	N(%)	0.780
Single	44	53.7	7	46.7	51(52.6)	
Multiple	38	46.3	8	53.3	46(47.4)	
Total	82	100.0	15	100.0	97(100.0)	

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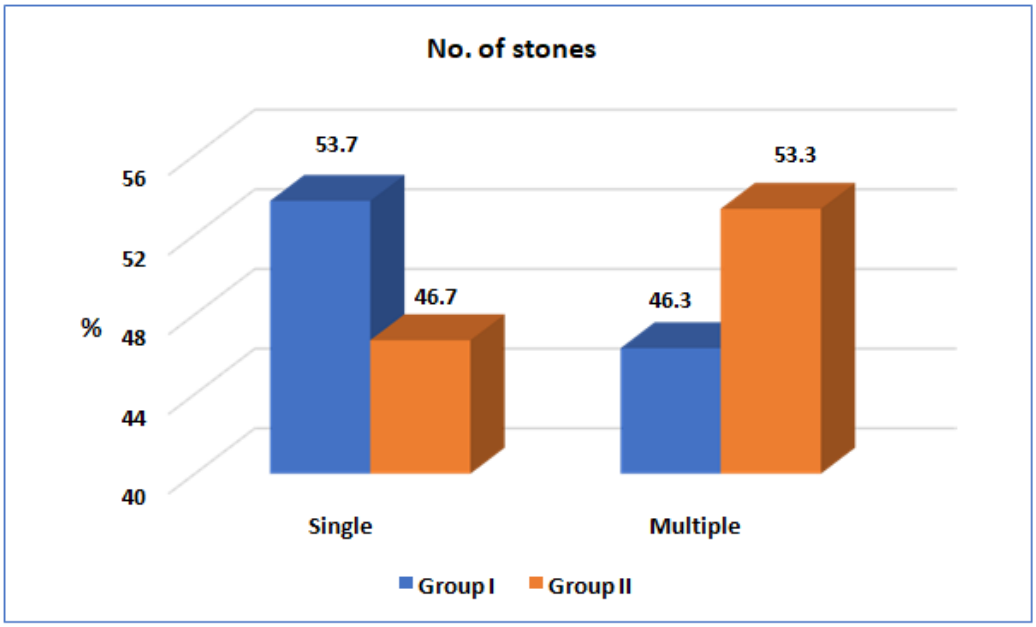

FIGURE 3. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE NUMBER OF STONES

TABLE 4. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE LOCATION OF STONES.

Groups / Stones Location	Group I Postop pain- (VAS <7)		Group II Postop pain (VAS>7)		Total	P value
	N	%	N	%	N(%)	
Upper and Middle pole	29	35.4	6	40	35(36.1)	0.942
Pelvis	29	35.4	5	33.3	34(35.1)	
Inferior	24	29.3	4	26.7	28(28.9)	
Total	82	100.0	15	100.0	97(100.0)	

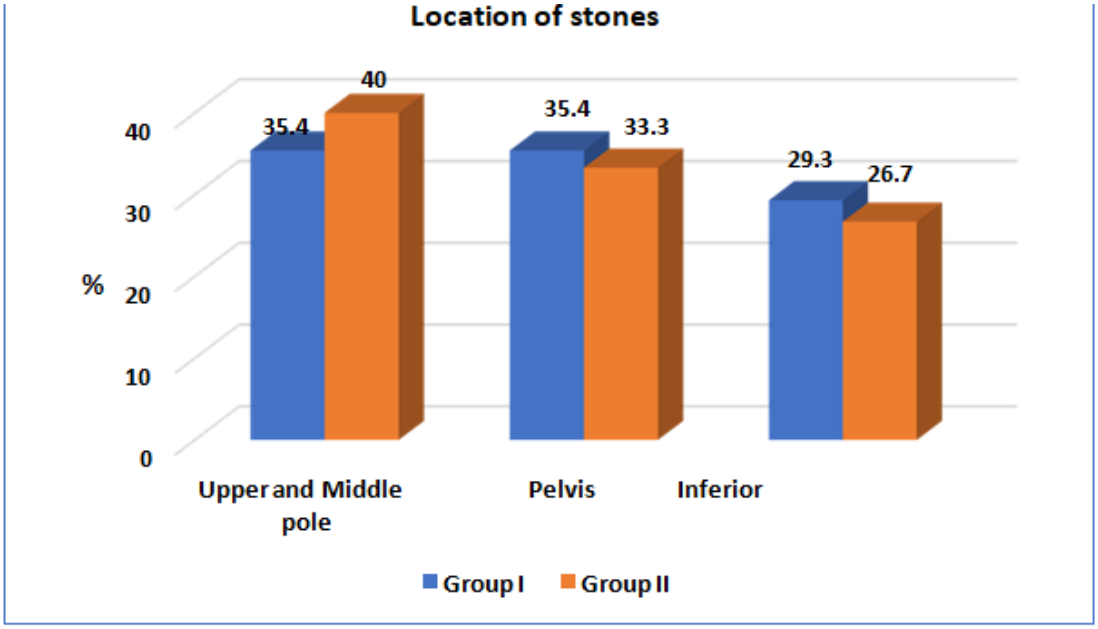

FIGURE 4. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE LOCATION OF STONES

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TABLE 5. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON STONES SIZE (IN MM)

Groups / Stones Size (in mm)	Group I Postop pain- (VAS <7)		Group II Postop pain -(VAS>7)		Total	P value
	N	%	N	%	N(%)	
< 10mm	65	79.3	9	60.0	74(76.3)	0.199
>10 mm	17	20.7	6	40.0	23(23.7)	
Total	82	100.0	15	100.0	97(100.0)	

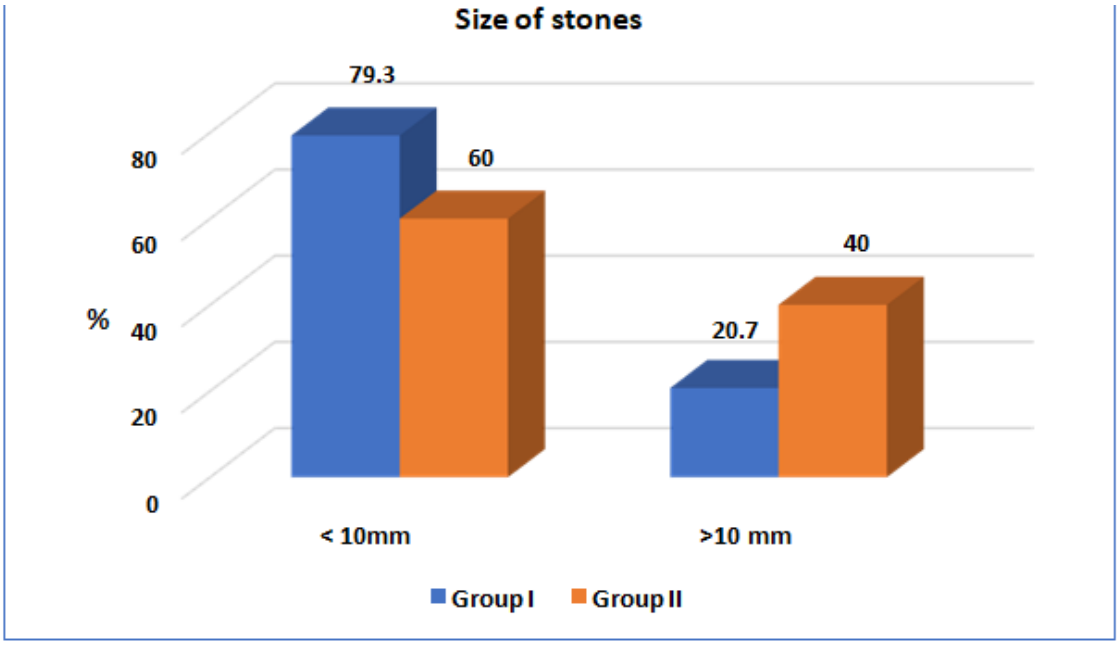

FIGURE 5. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON STONES SIZE (IN MM)

TABLE 6: DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE SIZE OF THE URETER ACCESS SHEATH

Groups / Size of ureter access	Group I Postop pain- (VAS <7)		Group II Postop pain -(VAS>7)		Total	P value
	N	%	N	%	N(%)	
10.7FR/45CM	58	70.7	7	46.7	65(67)	0.027*
10.7FR/35CM	20	24.4	4	26.7	24(24.7)	
9.0FR/45CM	2	2.4	1	6.7	3(3.1)	
9.0FR/35CM	2	2.4	3	20.0	5(5.2)	
Total	82	100.0	15	100.0	97(100.0)	

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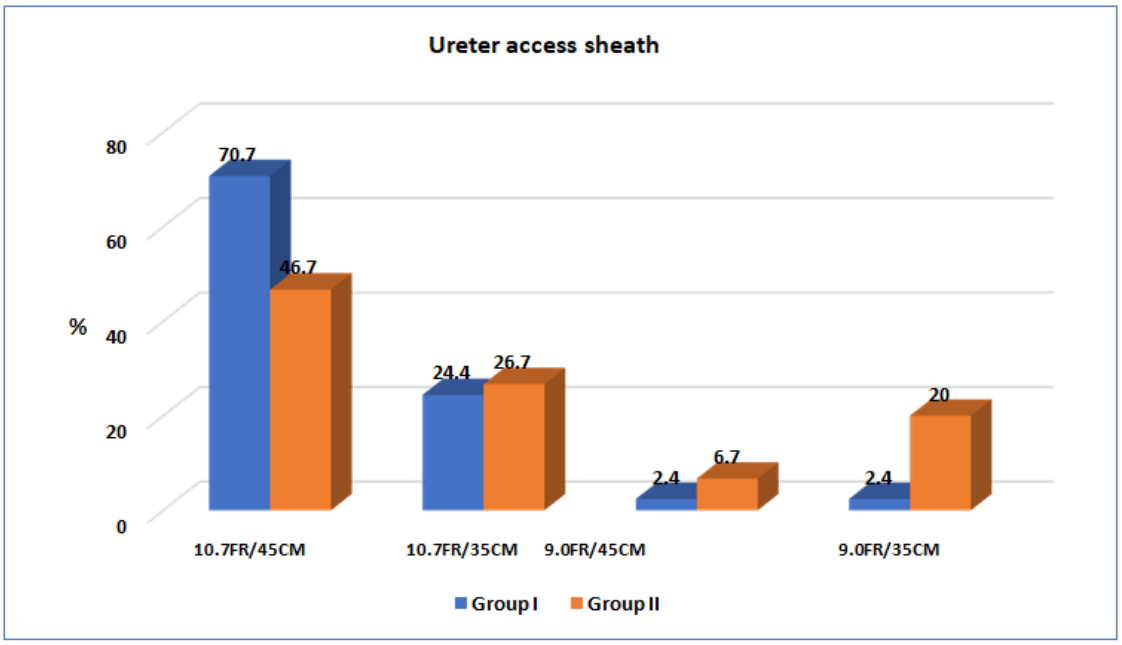

FIGURE 6. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON THE SIZE OF THE URETER ACCESS SHEATH

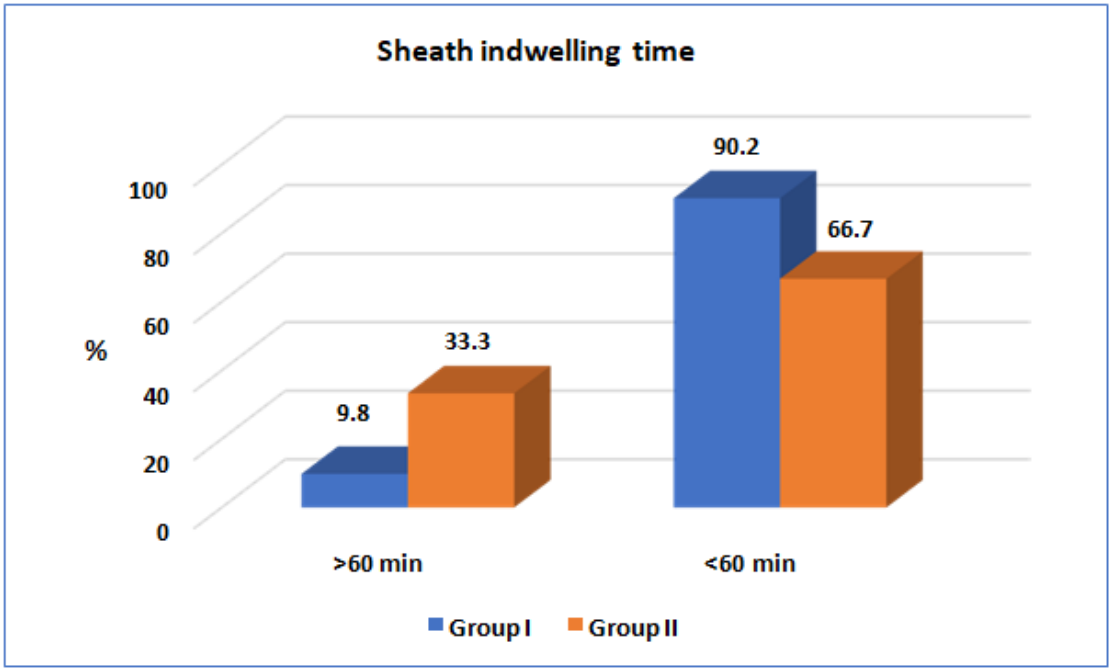

FIGURE 7. DISTRIBUTION OF SAMPLES BETWEEN THE TWO GROUPS BASED ON SHEATH INDWELLING TIME

DISCUSSION

The present prospective study evaluated multiple factors associated with postoperative pain in patients undergoing RIRS for kidney stones. Our findings underscore the multifactorial nature of postoperative pain where technical aspects of the surgery appear to play a more critical role than many patient- or stone-related factors. Although demographic variables such as age and gender, as well as stone characteristics like number, size, and location, have been implicated in previous reports [1, 3, 4], our data did not reveal significant differences between patients with lower versus higher VAS scores, suggesting that these parameters may be less influential than previously thought.

The most significant findings of this study relate to operation-related factors. Notably, both the size of the ureteral access sheath and its dwell time were associated with higher postoperative pain scores. The finding that smaller-diameter access sheaths were correlated with increased pain may be explained by the increased intraluminal pressure and ureteral

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manipulation necessary to navigate the anatomy with a more constricted device [5, 8]. Moreover, prolonged indwelling time of the sheath likely results in sustained mechanical irritation of the ureteral wall, triggering an inflammatory cascade that increases the patient's pain perception. These findings are consistent with earlier reports suggesting that minimizing intraoperative trauma can lead to improved postoperative outcomes [2, 7-9].

In contrast, our analysis did not support a significant association between preoperative hydronephrosis, prior DJ stenting, or stone density and postoperative pain. These results suggest that while these factors may be important for surgical planning and predicting overall stone clearance, they may not have a profound impact on pain outcomes. It is also possible that standardized perioperative analgesia protocols, including the use of paracetamol and the administration of anticholinergics to mitigate stent-induced discomfort, may have contributed to homogenizing pain responses across different patient subsets.[10-13]

Another notable observation was the absence of a significant difference in pain scores between patients with and without renal anomalies, bleeding, infection, or ureteral injury. This suggests that in the context of a carefully monitored and standardized surgical protocol, adverse events and minor complications do not necessarily translate into increased subjective pain perception. It is critical to note, however, that these findings could be influenced by the relatively small number of patients experiencing these complications, thus warranting further investigation.[14-16]

Our study provides important insights for urologists aiming to minimize postoperative discomfort following RIRS. By identifying technical variables—specifically sheath diameter and indwelling time—as significant predictors of pain, surgeons may be able to adjust operative techniques. Future investigations should explore whether modifications in sheath selection or a reduction in dwell time could serve as effective interventions to decrease postoperative pain. Additionally, larger multicenter studies would further validate these findings and help refine patient-specific pain management strategies.

CONCLUSION

In conclusion, this prospective study highlights that while many patient- and stone-related factors remain comparable among RIRS patients, operation-related variables—particularly the size of the ureteral access sheath and its indwelling time—are significant predictors of postoperative pain. These findings emphasize the need for careful intraoperative planning and tailored surgical techniques to minimize ureteral trauma. Preoperative identification of high-risk patients enables the refinement of pain management protocols, ultimately enhancing patient outcomes and satisfaction following RIRS.

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