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# Outcome of Flexible Ureteroscopy in Renal Stones

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## ABSTRACT

**Background:** Determining the risk factors of stone residual is critical in order to assist urologists in determining the potential results of retrograde intrarenal surgery (RIRS) and whether or not the patient will require further intervention following RIRS.

**Aim:** This study aimed to evaluate the efficacy and safety of RIRS for the treatment of renal stones and to analyze the predictive factors for stone-free rates.

**Methods:** This interventional prospective cohort study was conducted over a period of 18-months from July 2021 to January 2023. Two hundred patients suffering from renal stones were chosen from The Outpatient Clinics of Urology Departments, Helwan University Hospitals and Ain Shams University. Stone-free predictive criteria were evaluated.

**Results:** Stone size, number, and location, as well as surgeon's experience, are crucial indicators of how well a treatment will work. Furthermore, it was discovered that the Resorlu-Unsal stone score (RUSS) was a trustworthy method for estimating the possibility of residual stones following RIRS.

**Conclusion:** Surgeons can use predictive factors of stone-free information to more effectively choose patients for RIRS and modify therapy regimens to maximize results. The results further emphasized how crucial it is to perform RIRS procedures with precise technique and close attention to the patient's and the stone's features in order to reduce the possibility of residual stones.

**Keywords:** Renal calculi, Lithotripsy, Ureteroscopy.

## INTRODUCTION

Retrograde intrarenal surgery (RIRS) has experienced significant developments in technology in recent years, resulting in increased success rates for the treatment of renal stones. This has made it one of the most popular treatments in this field. The introduction of smaller, more flexible ureteroscopes and improved deflection mechanisms has played a crucial role in these improvements [(1)].

Given the rarity of serious complications after the procedure, retrograde intrarenal surgery can be considered a reasonably safe treatment. It is possible to have both intraoperative and postoperative complications. Of these, residual stones are particularly important since they may need additional treatments. [(2)].

Our goal in this study was to identify the variables that contribute to a higher occurrence of any remaining stones after RIRS. A total of 100 individuals diagnosed with kidney stones of lower size than 3 cm were included in this study. Prior to surgery, each patient had a preoperative history that was taken, complete laboratory and radiological workup and for every patient, a Resorlu-Unsal stone score (RUSS) was developed and computed. Assessments both intraoperatively and postoperatively were then completed.

## PATIENTS AND METHODS

This interventional prospective cohort study started in July 2021 and ended in January 2023. It was conducted on a total of two hundred individuals with renal stone in Urology Departments' Outpatient Clinics at Helwan University and Ain Shams University Hospitals. The study examined patients whose renal stones measured less than 3 cm. Patients with staghorn stones, preoperative UTIs, and those deemed unfit for surgery were excluded from the study. Every patient underwent a physical examination and history taking to evaluate body weight, height, body mass index (BMI) and anatomical anomalies such as horseshoe kidney and pelvic kidney, as well as prior surgical experiences including ureterovesical reimplantation, solitary kidney, postcystectomy, and preoperative stenting. Complete blood counts (CBC), urine cultures and sensitivity tests, kidney function tests, and coagulation profiles were among the laboratory investigations carried out.

Radiology studies included computed tomography urinary tract (CTUT) without the use of contrast, kidney-ureter-bladder X ray (KUB) and the Resorlu-Unsal stone score (RUSS). A total score was computed for each patient with total score (0–4).

The collection of intraoperative data included variables such as type of anesthesia, surgeon experience (less than 50 fURS or more than 50 fURS), the duration of the procedure, the duration from the beginning of cystoscope insertion to the end of stent application, the laser power and settings (energy and frequency), and the incidence of any complications throughout the procedure (bleeding), and the size of the stent.



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The post-operative data included stone fragments that were sent for chemical analysis to determine the content of the stone.

**Follow-up:** When the stent was removed, KUB was performed. After 30 days following the operation, patients were assessed using non contrast CT urinary tract. Stone-free condition is defined as having 3 mm stone size or less. The same urologist and radiologist assessed the CTUT scans before and after surgery.

**Ethical approval: Ethical approval was granted by The Ethical Committee of Faculty of Medicine, Helwan University (IRB number 39-2021). Written informed consents were obtained from all study population. The Helsinki Declaration was followed at all stages of the study.**

***Data analysis***

The data were analyzed using IBM SPSS Statistics version 23, developed by IBM Corp. in Armonk, NY, USA. The following tests were used: unpaired t-test, Mann Whitney U-test Chi-squared test and Fisher's exact test. The study employed multivariate regression analysis to establish a correlation between the variables under investigation and the residual stone after RIRS. The criterion for statistical significance was ≤ 0.05.

## RESULTS

Table (1) showed demographic characteristics among the studied cases. Mean age was 45.3 ± 10.7 years. 63.0% were males, while 37.0% were females.

**Table (1):** Demographic characteristics among the studied cases

| Variables | | Mean±SD | Range |
|---|---|---|---|
| **Age (years)** | | 45.3±10.7 | 22.0–71.0 |
| **BMI (kg/m$^2$)** | | 26.2±1.4 | 21.5–29.9 |
| | | **N** | **%** |
| **Sex** | **Male** | 126 | 63.0% |
| | **Female** | 74 | 37.0% |

Total=200. BMI: Body mass index

Table (2) showed that lower calyx was the most frequent site (36.0%). Majority of stones were solitary (86.0%), and of size 10-20 mm (69.0%). The intensity was mainly opaque (76.0%). Abnormal anatomy was uncommon (1.0%). Hydronephrosis was in 73.0% of cases. RUSS score was 0, 1, 2 and 3 in 35.0%, 51.0%, 12.0% and 2.0% respectively.

**Table (2):** Radiological findings among the studied cases

| Variables | | Mean±SD | Range |
|---|---|---|---|
| **Size (mm)** | | 18.2±4.4 | 10.0–29.0 |
| | | **n** | **%** |
| **Size** | **10-20 mm** | 138 | 69.0% |
| | **21-30 mm** | 62 | 31.0% |
| **Side** | **Right** | 76 | 38.0% |
| | **Left** | 124 | 62.0% |
| **Site** | **Upper calyx** | 60 | 30.0% |
| | **Middle calyx** | 48 | 24.0% |
| | **Lower calyx** | 72 | 36.0% |
| | **Pelvis** | 48 | 24.0% |
| | **Multiple** | 24 | 12.0% |
| **Number** | **Solitary** | 172 | 86.0% |
| | **Multiple** | 28 | 14.0% |
| **Intensity** | **Opaque** | 152 | 76.0% |
| | **Lucent** | 48 | 24.0% |
| **Abnormal anatomy** | | 2 | 1.0% |
| **Hydronephrosis** | | 146 | 73.0% |
| **RUSS** | **0** | 70 | 35.0% |
| | **1** | 102 | 51.0% |
| | **2** | 24 | 12.0% |
| | **3** | 4 | 2.0% |
| | **4** | 0 | 0.0% |

Total=200

Table (3) showed the surgical findings among the studied cases. Preoperative stent was infrequent (4.0%). Almost all cases (99.0%) had general anesthesia. The majority of surgeons (71.0%) had experience ≥ 50.0 operations. Most operations' durations were ≥ 90.0 minutes.

**Table (3):** Surgical findings among the studied cases

| Variables | | n | % |
|---|---|---|---|
| **Preoperative stent** | | 8 | 4.0% |
| **Anesthesia** | **General** | 198 | 99.0% |
| | **Spinal** | 2 | 1.0% |
| **Surgeon experience** | **<50** | 58 | 29.0% |
| | **≥50** | 142 | 71.0% |
| **Surgery duration** | **<90.0 min.** | 62 | 31.0% |
| | **≥90.0 min.** | 138 | 69.0% |
| | | **Mean±SD** | **Range** |
| **Surgery duration (min.)** | | 97.0±13.4 | 62.0–118.0 |

Total=200

Figure (1) showed that intraoperative injury, postoperative fever and postoperative sepsis were infrequent (1.0%, 2.0% and 1.0% respectively).

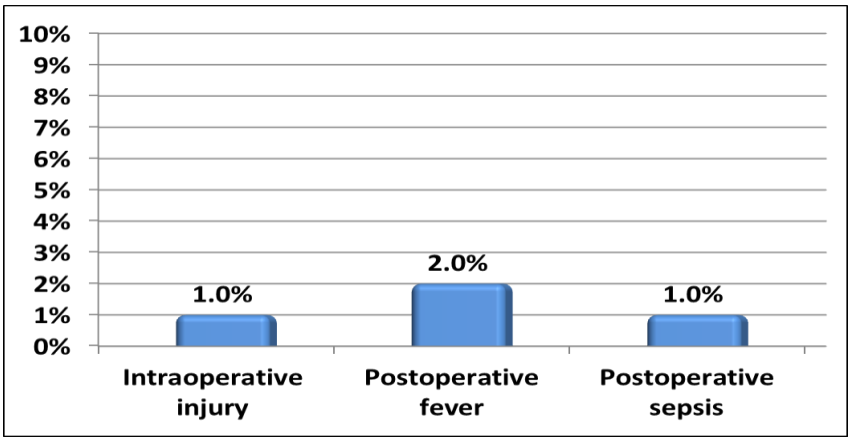


**Fig (1):** Complications among the studied cases**.**

Figure (2) showed that stone residual was in less than one fifth of cases (19.0%).

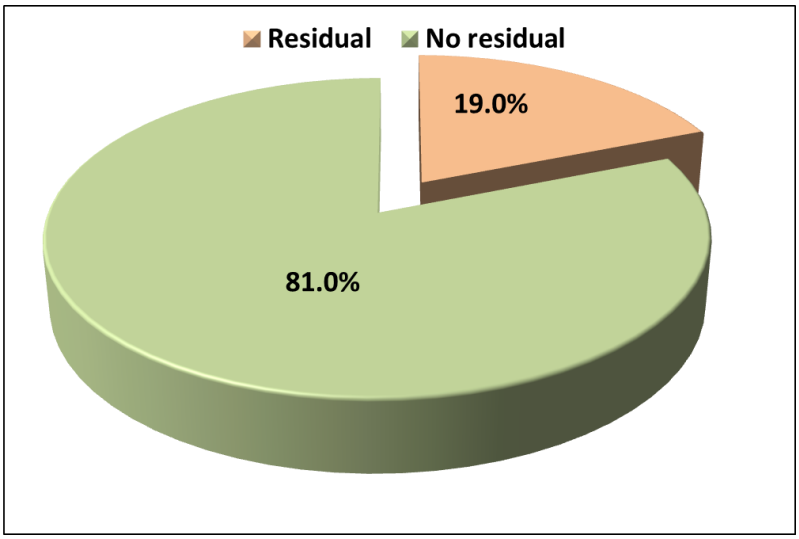


**Fig (2):** Stone residual among the studied cases.

Figure (3-6) displayed that there were no statistically significant differences seen based on the residual size of the stones, stone side, abnormal anatomy and hydronephrosis. Lower calyx site, multiple sites, multiple stones and high RUSS scores were significantly more frequent in cases with residual stone.

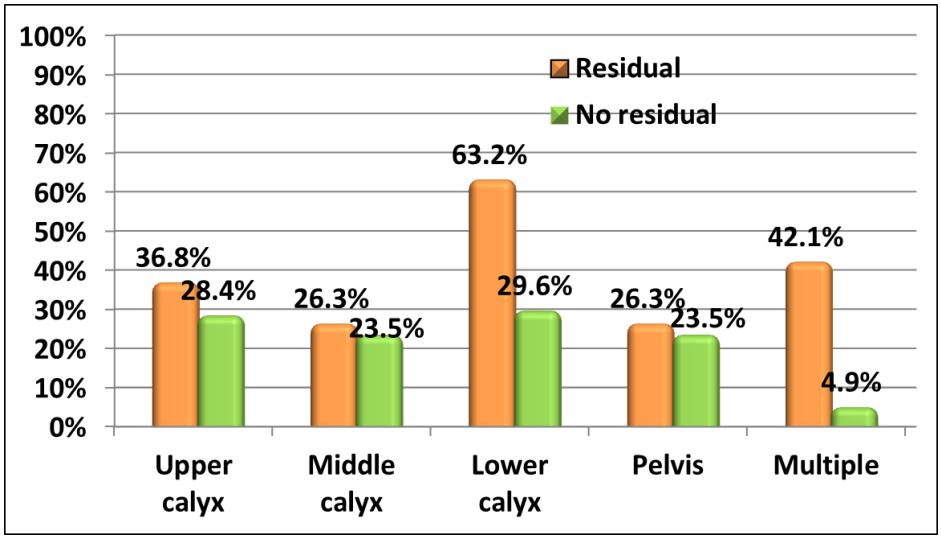


**Fig (3):** Comparison according to stone residual regarding stone site.

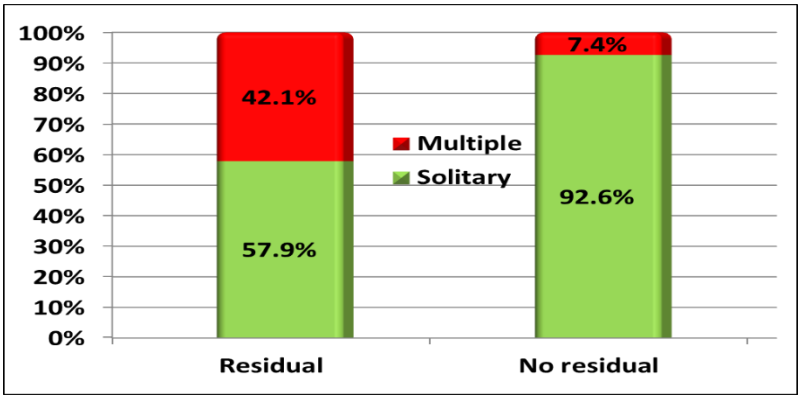


**Fig (4):** Comparison according to stone residual regarding stone number.

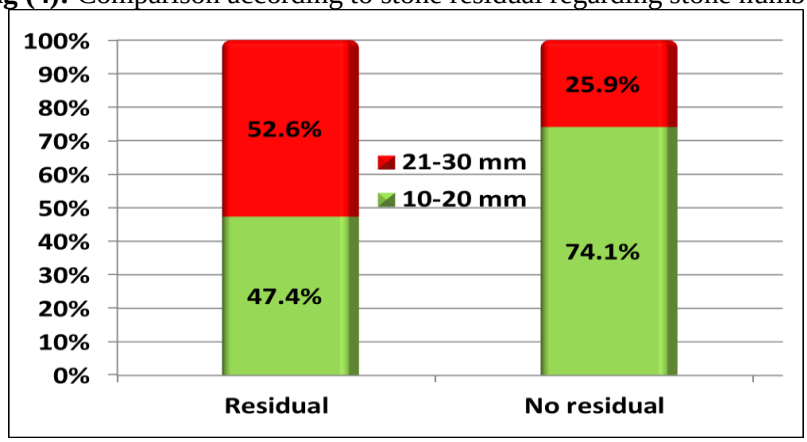


**Fig (5):** Comparison according to stone residual regarding stone size.

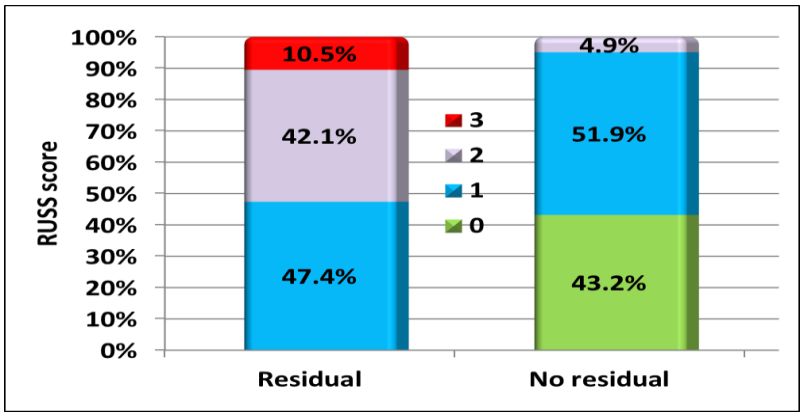


**Fig (6):** Comparison according to stone residual regarding RUSS score.

Figure (7) showed that surgeon low experience was significantly more frequent in cases with residual stone.

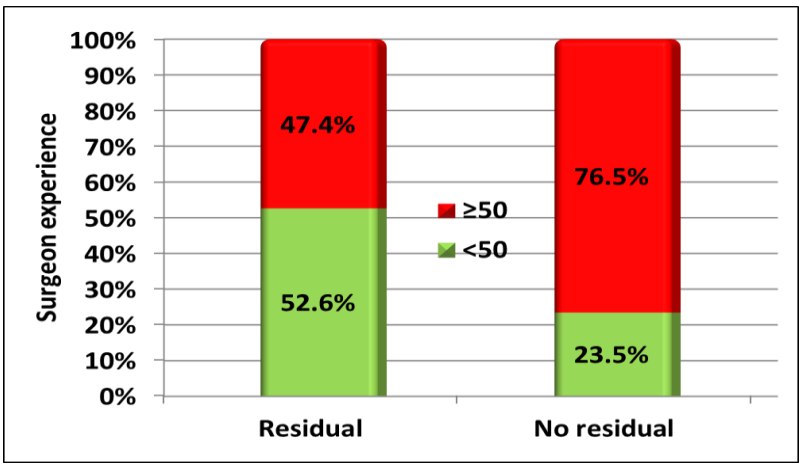


**Fig (7):** Comparison according to stone residual regarding Surgeon experience

Figure (8) showed that the occurrences of intraoperative injury, postoperative fever, and postoperative infection were not statistically significant and were more frequent in cases with residual stone.

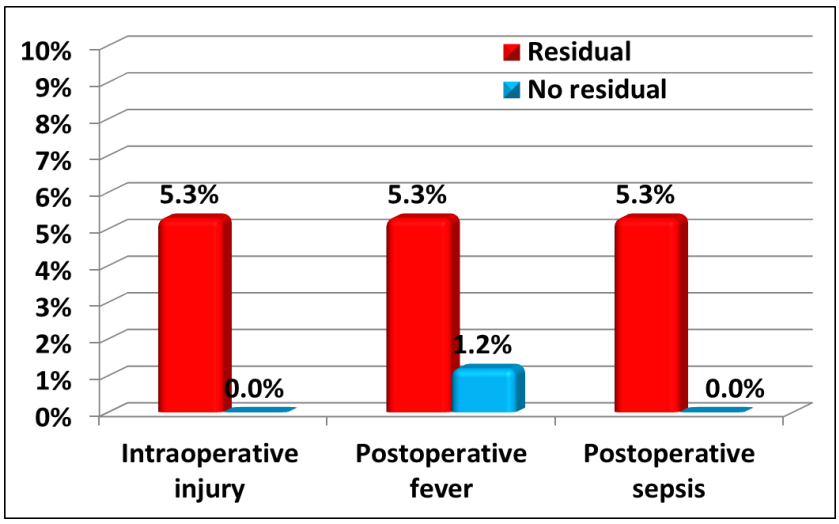


**Fig (8):** Comparison according to stone residual regarding complications

Figure (9) showed that the RUSS score demonstrated a noteworthy ability to accurately predict the presence of residual stones. RUSS score ≥ 2.0 had high specificity and diagnostic accuracy and negative predictive value.

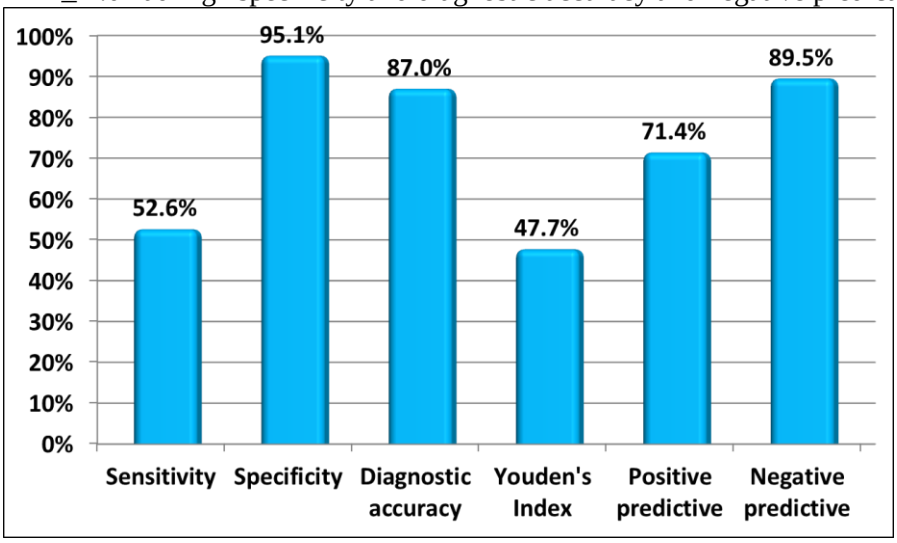


**Fig (9):** Diagnostic characteristics of The RUSS score is used to predict the presence of residual stones.

Table (4) demonstrated that there were multiple sites and multiple numbers of occurrences, with a size range between 21 and 30 millimeters. The location of the lower calyx and the skill level of the surgeon experience < 50 were significant independent factors increased the likelihood of residual stones occurrence, their effect strength were in order from highest to lowest.

**Table (4):** Logistic regression for independent factors affecting residual stones

| Factors | Univariable | | Multivariable | |
|---|---|---|---|---|
| | OR (95% CI) | p-value | OR (95% CI) | p-value |
| **Multiple sites** | 14.0 (3.61– 54.347) | **<0.0021 *** | 24.98 (3.39 – 183.04) | 0.002 |
| **Multiple number** | 9.09 (2.65– 31.20) | **<0.0012 *** | 13.62 (2.52 – 73.60) | 0.002 |
| **Size 21-30 mm** | 3.18 (1.14–8.88) | **0.0280*** | 4.91 (1.09 – 22.15) | 0.038 |
| **Lower calyx site** | 4.07 (1.43– 11.60) | **0.00938 *** | 4.85 (1.14 – 20.64) | 0.033 |
| **Surgeon experience <50** | 3.63 (1.29– 10.23) | **0.01533 *** | 6.82 (1.36 – 34.31) | 0.020 |

OR: Odds ratio. CI: Confidence interval, *significant.

## DISCUSSION

The participants' average age was 45.3 ± 10.7 years, and the average body mass index was 26.2 ± 1.4 kg/m$^2$ with sixty-three male volunteers and 37 female participants.

The mean stone size measured 18.2 ± 4.4 mm with a range of 10.0–29.0 mm. Only one stone was found in the majority of individuals (86%) who had stones measuring between 10 and 20 mm in size. The lower calyx was the most common site for the presence of stones (36%), which was followed by the pelvis (24%). Seventy-three percent of patients had hydronephrosis. Each patient's RUSS score was determined; Out of the total, 35% obtained a score of 0, 51% obtained a score of 1 and 2% obtained a score of 3.

In terms of the operative outcomes, surgeons who completed 50 or more fURS operations performed 72% of the surgeries. With 69% of surgeries took 90 minutes or more, the average surgery time was 97.0 ± 13.4 minutes. There was a 1.0% incidence of intraoperative injury, 2.0% incidence of postoperative fever, and 1.0% incidence of postoperative infection and were noted as minimal complications. After the RIRS surgery, residual stones were seen in about 19% of the patients. The presence of residual stones was substantially correlated with the size, location, and presence of multiple stones.

Furthermore, patients with stones sized between 21 and 30 mm, smaller calyx stones, and surgeons experience with fewer than 50 cases were more prone to have residual stones, according to multivariable logistic regression.

In cases where there remained residual stone, a high RUSS score was substantially more common. Furthermore, with a sensitivity of 52.6%, specificity of 95.1%, and diagnostic accuracy of 87.0%, the RUSS score demonstrated strong diagnostic performance in predicting stone residual.

Our findings are consistent with those of several other researches regarding the significance of stone size, quantity, and location in predicting the occurrence of residual stones. After flexible ureteroscopy, **Ito *et al.*** [4] looked into whether parameters can predict the spontaneous clearance of residual renal fragments. 546 patients who had flexible ureteroscopy combined with lithotripsy were included in the study. After flexible ureteroscopy, the number of stones, the presence of lower pole calculi and the occurrence of residual renal fragments were identified as separate factors that predict the spontaneous clearance according to multivariate analysis.

**Alazaby *et al.*** [5] assessed the safety and effectiveness of RIRS as a therapeutic option for numerous renal stones larger than 1 cm using F-URS. Evaluations were conducted on forty-two individuals who received RIRS treatment using F-URS. This study clearly demonstrated the impact of stone position, quantity, and size. Eight patients had SFR of 100% when their stone burden was between 11 and 20 mm, whereas 34 patients with an SFR of 91.2% (31/34) had a stone burden between 21 and 30 mm. Two patients (73.8%), three patients (21.4%), and four patients (4.8%) had one or more stones per renal unit. The corresponding SFRs were 100%, 77.7%, and 50% respectively. With respect to the location of stones in each kidney, 6 patients (14.3%) had stones in the renal pelvis, 12 patients (286.6%) had upper pole calyx ± mid calyx ± renal pelvis, and 24 patients (57.1%) had lower pole calyx ± any other location. The corresponding SFRs were 100%, 91.6% (11/12), and 91.6% (22/24) for these three groups of patients.

**Ito *et al.*** [6] assessed the likelihood of recurrent surgery and stone-related events after fURS for renal stones, in order to determine their predictive characteristics. A retrospective cohort analysis was carried out on 664 individuals who had renal stone surgery using fURS. Stone burden greater than 20 mm was significantly correlated with remaining stones and additional future intervention.

**Elbakary** [7] assessed the effectiveness of using flexible ureteroscopy (fURS) in combination with laser lithotripsy to treat renal calculi that are larger than 2 cm. The goal was to determine the variables that can impact the results of the treatment. He enlisted 47 patients who had flexible ureteroscopy (fURS) with laser lithotripsy to address renal calculi that were greater than 2 cm in size. The stone clearance percentage was 90.7% for stones measuring 3 cm or less, and 75% for stones over 3 cm in size. The results are in line with our findings and can be attributed to the fact that larger stones require more fragmentation and extraction, there is a higher probability of residual material fragments. Furthermore, the positioning of the stones within the kidney is a crucial factor in determining the probability of remaining stones following RIRS. More precisely, stones found in the lower calyx were associated with a higher likelihood of stones persisting. This is attributed to the challenge of gaining entry to these regions during the course of the treatment.

**Tonyalı *et al.*** [8] evaluated potential factors influencing the achievement of a stone-free condition following RIRS that was performed on a group of 100 patients. Individuals with stones located in the lower pole had a 2.25-fold increased probability of having remaining stones after undergoing RIRS compared to those with stones in other areas ($p < 0.001$). Similarly, **Gross *et al.*** [9] found that the presence of many stones and stones situated in the lower caliceal group were linked to a decreased percentage of complete stone clearance and may necessitate several treatment sessions.

Contradicting to these results, **Jacquemet *et al.*** [10] and **Martin *et al.*** [11] reported that the presence of a stone in the bottom pole did not impact the stone free rate. The study revealed that the stone free rate (SFR) for lower pole was 74.1%, which was statistically similar to the SFR (78%) of stones found in other locations ($p=0.224$).

This may be because their surgeons had far more expertise than ours, or because the majority of the cases in their study had an infundibulopelvic angel broader than 45 degrees.

Our study found that the level of experience of the surgeon plays a significant effect regarding the accomplishment of RIRS. Patients who underwent surgery performed by less experienced surgeons had a greater probability of having residual stones following the treatment.

**Berardinelli *et al.* [12]** examined whether surgical expertise would have an impact on the results of RIRS with regard to the rate of complications and stone clearance. There were two groups of patients. Group 1 consisted of patients treated by three surgeons in the early stages of their learning curve (surgical experience < 100 procedures) and group 2 consisted of cases performed by two highly experienced endourologists (>400 procedures). The findings showed that while the rates of stone-free patients were comparable in both groups, the group with more experienced endourologists generally had higher success rates (70 vs. 77.9%). There are multiple explanations for this observation. Initially, the study only included individuals with comparable stone features who had surgery. Furthermore, it is feasible to attain a stone-free rate that is comparable to what has been reported in the literature, even with a limited number of surgeries performed by the surgeons. The reason for this is because RIRS does not have the same level of difficulty in terms of access as PCNL. The source of this phenomenon is readily apparent, as a proficient surgeon have the knowledge to recognize their boundaries, knowing precisely when to cease for the sake of safety and when to persist. Furthermore, he possesses the knowledge and skills to effectively address and solve challenges in a more efficient manner. This is also corroborated in the literature: The duration of the operation is a contributing factor that heightens the likelihood of problems [13].

The current study found that the RUSS score has a high level of specificity. Specifically, patients with a score of 2 or higher are most probable to have residual stones. These findings align with prior research by **Resorlu *et al.* [3]** who found a strong correlation between higher RUS scores and lower stone-free rates following RIRS. **Sfoungaristos *et al.* [14]** conducted a retrospective analysis to validate the RUS score and assess its prediction accuracy. The postoperative outcomes showed a substantial correlation with the Retrograde Ureteral Stone Score (RUSS) and the size of the stone. RUSS emerged as the only significant independent predictor in the multivariate study, exhibiting a high degree of predictive precision. Based on these data, the RUSS score demonstrates a high level of diagnostic accuracy and sensitivity suggesting that it can effectively detect the existence of residual stones. The RUSS system can assist in determining the optimal surgical technique for each patient. For instance, in patients with RUSS scores of 2 or above, percutaneous nephrolithotomy (PCNL) may be a more efficacious treatment compared to retrograde intrarenal surgery (RIRS). Furthermore, individuals with elevated RUSS scores may experience advantages from undergoing multiple sessions or a longer duration of surgery in order to guarantee the thorough elimination of stones. Hence, the implementation of the RUSS score can significantly reduce both intraoperative and postoperative difficulties in patients with renal stones.

## CONCLUSION

This study offered useful insights into the parameters linked to the presence of remaining stones following retrograde intrarenal surgery (RIRS), which is a procedure used to treat kidney stones. The results indicated that the size, quantity, and site of stones, together with the expertise of the surgeon, are significant factors in predicting the success of treatment. Moreover, the reliability of the RUSS score was established for prediction of the probability of residual stones following RIRS. Surgeons can utilize this information to enhance their patient selection for RIRS and customize treatment strategies to maximize the desired results. Moreover, the results emphasized the significance of precise methodology and thorough consideration to minimize the occurrence of residual stones, it is important to carefully consider the characteristics of both the patient and the stone during RIRS treatments.

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**Conflicts of interest:** There are no conflicts of interest, according to the authors.

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