Original Article

A Comparative Study of Stone Clearance Rates in Retrograde Intrarenal Surgery (RIRS) for Kidney Stones Above and Below 1.5 cm in Size

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ABSTRACT

Objective: To analyse stone clearance rates in RIRS patients with stones larger than 1.5 cm compared to those with smaller stones, providing insight into RIRS's potential as a preferred approach for kidney stone management.

Study Design: Retrospective cohort study

Place and Duration of Study: This study was conducted at the Urology department of The kidney Centre Postgraduate Training Institute from the time period of May 2023 to June 2024.

Methods: 151 patients who underwent RIRS at The Kidney Centre Postgraduate Training Institute over a period of one year. Cohorts: - Group A: Stones <1.5 cm. Group B: Stones ≥1.5 cm. **Data Analysis**: SPSS, p-value ≤0.05 considered significant.

Results: Complete Clearance in Group A: 79.6% and Group B: 60.5%. Residual Stone Fragments Less than 4 mm on X-ray or Ultrasound Group A: 16.7% and Group B: 34.9%.

Conclusion: RIRS, in selected cases, can be effective for larger stones (≥1.5 cm) with comparable clinically significant clearance. -Advantages over PCNL include minimal invasiveness, faster recovery, lower morbidity.

Key Words: Percutaneous Nephrolithotomy, PCNL, RIRS, Retrograde Intrarenal Surgery, Stone Clearance.

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INTRODUCTION

The prevalence of kidney stones and their impact on health and quality of life is significant. Retrograde Intrarenal Surgery (RIRS) is a minimally invasive technique widely used to manage kidney stones. However, stone size plays a crucial role in the success rates of this procedure[1].

Historically Larger stones were treated with open Pyelolithotomy until the advent of Percutaneous Nephrolithotomy, aided by the development of FIbreoptics and Nephroscopes. These revolutionized the field of stone treatment by allowing a minimally invasive approach to clear renal stones larger than 2 cm or in difficult anatomical location[2]. Smaller stones were fragmented with extracorporeal lithotripsy, with advances in Ultrasonic Shockwave Lithotripters improving the fragmentation of stones while also making the process safer for the patient by reducing the impact the process has on the kidney parenchyma. Nonetheless, a gray area still existed because of variability in Stone composition and hardness as well as stones in anatomically difficult locations. Particularly challenging were the stones present in narrow neck calyces and those resistant to shockwaves lithotripsy.

For stones between 1 and 2 cm, modern guidelines advocate the use of these multiple procedure options as a sort of armamentarium[3], with decisions regarding treatment based on all these factors combined. Regardless, there is significant morbidity associated with PCNL procedures, with risk of hemorrhage, significant post op pain and respiratory complications for upper pole access concomitant, as it is essentially a controlled grade 4 trauma.

Development of Flexible scopes has had a revolutionizing effect on the field of Renal Stone Surgery, providing direct access, visualization and fragmentation of renal stones without a single incision. The great advancement in the field of Laser energy sources, particularly Holmium YAG Lasers, has helped. These developments have now made RIRS a cost effective as well as the safest approach to the management of Kidney stones between 1-2cm in size[4].

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Whether it is yet the most cost effective option in an economically challenged setting is yet to be determined[5].

Any attempt to treat renal stone consists of the following principle steps. 1) Identification of the Stone, its size, hardness and location within the Kidney, 2) Access to the stone, 3) fragmentation of the target stone via a viable energy source, such as Ballistic Lithoclast, Ultrasonic Shockwaves or laser energy sources, and lastly 4) clearance of the stone fragments from the system. Retrograde Intrarenal surgery for stones using flexible ureterorenoscopes provides us with excellent results in the first three of these steps, with the exception of stones in the lower calyx with a very acute angle. New advancements in scope engineering have greatly improved our ability to target even these lower pole stones with acute angles. While new laser fibers allow transmission of more power with greater flexibility owing to the thinness of the fibers themselves. Regardless, clearance of the fragmented stones depends upon the natural anatomy of the system, and this has always given pause to the Urologist treating renal Stones. How large is too large is a question even today.

With this study, we aim to compare the stone clearance rates in patients undergoing RIRS for kidney stones larger and smaller than 1.5 cm. In Pakistan, Stone disease is endemic and our Centre, the Kidney Centre Post graduate Training Institute, has specialized in treating renal stones over the last 30 years. The recent availability of disposable Flexible Ureterorenoscopes of 7.5FR has dramatically reduced the cost of this procedure, which was otherwise too expensive for our resource poor population. Over the last 5 years, we have seen a progressive and sustained increase in our RIRS case count. We have also witnessed a growing confidence in our ability to manage stones up to and greater than 2 cm in size, especially in patient groups who are not suitable for PCNLs, such as those with difficult anatomies, on anticoagulation medications or recurrent stone formers who are CKD as well those with solitary functioning kidneys. Through this study we aim to determine if the clearance rates for RIRS in larger stones (>1.5cm) is comparable to smaller stones.

METHODS

This study used a retrospective cohort design to evaluate stone clearance rates in patients who underwent Retrograde Intrarenal Surgery (RIRS) at The Kidney Centre Post Graduate Training Institute, specifically targeting stones sized above and below 1.5 cm. Ethical approval was obtained from The Kidney Centre Ethical Review Committee, and the study was granted exemption for patient contact due to its retrospective nature, under reference No: 181-URO-082024 (EXEMPTION).

Study Design

The retrospective cohort study included 151 patients with kidney stones, categorized into two groups: Group A with stones less than 1.5 cm and Group B with stones 1.5 cm or larger. This division allowed for a direct comparison between the two groups in terms of stone clearance, operative times, and associated outcomes.

Inclusion and Exclusion Criteria: Inclusion criteria specified patients aged 18 and above who underwent RIRS for kidney stones. Exclusion criteria included those with anatomical abnormalities, multiple stones, prior kidney surgeries, or any underlying conditions that might complicate the procedure.

Data Collection: Patient data were extracted from medical records, covering demographics (age and gender), stone characteristics (size, location), surgical details (operative time, access), and postoperative outcomes (clearance rates, complications, and hospital stay). As part of the Preoperative Workup protocol for Renal Stone Disease in the Kidney Centre, all new patients presenting with renal Stones undergo plain CT pyelogram, unless a recent (< 6 months) CT with films is available. Prior to any procedure for Renal Stones, a routine X-ray KUB is done with standard bowel prep to confirm stone location and visibility on x-ray. Post-operative Protocol requires that all patients undergo an initial X-ray KUB after Surgery to check for stone clearance and to confirm correct position of the DJ stent. Furthermore, a repeat X ray or an Ultrasound of the Kidney is undertaken after 2 weeks to assess for final clearance, depending on the radio-opacity of the stones on x-ray. Stone clearance (on x-ray or Ultrasound Kidney) is defined as the altogether absence of stones or the presence of fragments smaller than 4 mm, which are clinically insignificant. Present protocol for RIRS in the Kidney Centre requires the passage of Double j Stent in all patients undergoing surgery.

Statistical Analysis: Data were analyzed using IBM SPSS version 21. Mean and standard deviations were calculated for continuous variables (age, stone size, and operative time), while categorical variables (stone clearance, gender, complications) were reported as frequencies and percentages. The normality of continuous variables was checked using normality plots and the Shapiro-Wilk test. For normal data, an independent sample t-test was used, and for non-normally distributed data, the Mann-Whitney U test was applied. The Chi-square test determined associations between categorical variables, and a p-value of ≤ 0.05 was considered statistically significant.

RESULTS

We recruited 151 patients in our study with a mean age of 41.3 ± 14.1 years (Range 18 – 74 years). The baseline parameters of the patients were the similar in both groups. Group A had patients with renal stones less than 1.5cm on radiological investigations and consisted of 108 patients. Group B was composed of all

patients with stone sizes greater than 1.5 cm and had 43 patients. The ratio of Male to female patients was similar and reflects the predominant incidence rate of stone disease in world population.[7] The mean stone size in Group A was 0.98 ± 0.27 cm while in Group B it was 2.1 ± 0.23 cm.

Table No.1: Comparison of Baseline parameters of the patients of two groups n=151

Pre-operative variables	Group A Stone size < 1.5 cm	Group A Stone size ≥ 1.5 cm	P-Value
	Mean ± STD/ n (%)	Mean ± STD/ n (%)	
Age in years	40.5 ± 13.9	68.5 ± 8.1	0.291
Stone size	0.98 ± 0.27	2.1 ± 0.23	<0.001
Gender Male/ Female	80(74.4)/28(25.9)	33(76.7/10(13.3)	0.761

On comparing the two groups of patients, we observed that the mean operative time was significantly longer in the patients with larger stones (115.4 ± 37.3 v/s 134.1 ± 43.7 p=0.012), while the complete stone clearance was significantly lower in these patients as compared to the patients with smaller stones {86 (79.6%) v/s23 (60.5%) p= 0.038). Notably, clinically significant stone clearance (absence of stones or residual fragments ≤4 mm) was comparable between the two groups, with 96.3% (104 patients) in Group A and 95.3% (41 patients) in Group B, indicating effective stone management even in larger stones. However, operative time was significantly longer in Group B (134.1 minutes) compared to Group A (115.4 minutes), reflecting the increased procedural complexity for larger stones. On the other hand, the rate of pre and post-operative complications was the same in both groups (p > 0.05).

Table No.2: Comparison of para and post-operative variables between the two groups of patients Mean ± STD / n (%)

Para and post-operative parameters of the patients		Group A 108(71.5%) Stone size= < 1.5 cm	Group B 43(28.5%) Stone size= ≥ 1.5 cm	P-Value
Operative time		115.4 ± 37.3	134.1 ± 43.7	0.012
Hospital stay		1.1 ± 0.25	1.1 ± 0.43	0.761
Post-operative ESWL		5 (4.6)	1 (2.3)	0.675
Pos-operative pain		3 (2.8)	0	0.558
Post-operative Hematuria		2 (1.9)	0	0.59
Initial failure of access		1 (0.9)	1 (0.9)	0.999
Conversion to PCNL		1 (0.9)	1 (0.9)	0.999
Post-operative assessment modality	Visibility on X-ray	78 (72.7)	36 (86)	
	Visibility on ultrasound	30 (27.8)	6 (14)	0.072
Post-operative clearance	Complete	86 (79.6)	23 (60.5)	
	Residual < 4 mm	18 (16.7)	15 (34.9)	
	Residual ≥ 4 mm	4 (3.7)	2 (4.7)	0.038

The results also showed that prolonged operative time did not translate into greater complication rates. The incidence of post-operative hematuria, severe post-operative pain requiring Opioid Analgesia and prolonged Hospital stay was insignificant in both groups. Patients were discharged on the first post-operative day regardless of stone size. In both groups, failure of access was seen in only one case and conversion to PCNL was only recorded in one case.

DISCUSSION

A. Stone Clearance in Larger Stones and Its Implications. The data from our study underscores the capability of RIRS to achieve substantial clearance even in stones larger than 1.5 cm, a threshold where traditionally, PCNL would be the preferred method. The high clearance rates observed in both groups suggest that with advanced laser technology and improved access techniques, RIRS can provide comparable outcomes to more invasive methods, even for larger stones. This is not in contrast to the recent experiences and results obtained by other Stone Centers across the world.[9,10] These findings imply a shifting paradigm in stone management where RIRS could replace PCNL as a standard treatment, especially for patients unsuitable for more invasive surgeries. Stone size is one of the parameters which decide the course of treatment while its location, hardness and the anatomy of the kidney are also factors to be considered. For renal stones larger than 1.5 cm, RIRS is most

suitable in cases where the stone is not impacted at the PUJ or located at the lower pole with a sharp angle. Y Güleret al, in their paper published in 2021, evaluated the outcomes retrograde intrarenal surgery, antegrade ureterorenoscopy and laparoscopic ureterolithotomy in the treatment of impacted proximal ureteral stones larger than 1.5 cm. They concluded that in patients with impacted Stones at PUJ or Proximal Ureter, RIRS was likely to have poorer stone clearance rates and would require multiple sessions.[8] In contrast, our study participants were patients with non-impacted stones with favorable location and hence led to better post-operative results. Hence, when deciding the surgical approach to treating a renal stone, factors other than size must be kept in consideration.

B. RIRS vs. PCNL: Advantages and Drawbacks

RIRS offers significant advantages over PCNL.[11,12] The most notable benefits are the reduced invasiveness and the subsequent lower risk of hemorrhage, shorter recovery times, and reduced hospital stays. RIRS is also better suited for patients with anticoagulation therapy requirements, anatomical challenges, and single-functioning kidneys, where minimizing trauma is essential. Furthermore, RIRS avoids many of the complications associated with PCNL, such as the risks posed by upper pole access and the respiratory effects due to the prone position required in PCNL. Conventionally larger Stone size would be considered a prohibitive factor when choosing RIRS over PCNL. Our data shows that good stone clearance, comparable to PCNL, can be achieved with RIRS despite larger stone size.

However, RIRS is not without its limitations. The procedure is generally more time-consuming, as attested by our own findings, particularly in larger stones, due to the complex navigation required within the kidney. Lower pole stones also present challenges in RIRS, as the acute angles in these areas can limit access. Moreover, while advanced scopes and laser technologies have improved RIRS capabilities, the need for ongoing scope replacements and potential stone migration during the procedure remain significant considerations.

C. Limitations of This Study and Future Directions

Our study is limited by its retrospective design and reliance on medical records, which could introduce potential biases or inaccuracies. The sample size, while adequate for initial analysis, may not provide a comprehensive picture of RIRS efficacy across different populations or facilities with varying levels of expertise and technology.

Future research should focus on prospective studies with larger, multicenter populations to validate these findings and assess long-term outcomes, including recurrence rates and renal function preservation post-RIRS. Such studies could also investigate cost-effectiveness in diverse healthcare settings, particularly in economically challenged regions like Pakistan, where RIRS is becoming more accessible with disposable scopes.

CONCLUSION

Our findings highlight RIRS as a promising alternative to PCNL for kidney stones up to 2 cm, with excellent clearance rates achievable even in stones larger than 1.5 cm. The advantages of RIRS in reducing invasiveness and recovery time, while maintaining high stone clearance rates, make it a compelling choice in specific patient populations. Future prospective studies will be instrumental in confirming RIRS's role in broader clinical practice, potentially transforming kidney stone management paradigms globally.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Zeeshan Zafar, Shakeel Haseeb Uddin Siddique, Wajahat Fareed
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Agreement to accountable for all aspects of work:	All the above authors

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