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# Comparison of mini-percutaneous nephrolithotomy and retrograde intrarenal surgery for 1-2 cm renal stones: A single-center experience.

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## Abstract

**Background:** The management of renal stones has undergone significant advancements in recent years, with percutaneous nephrolithotomy (PCNL) and Retrograde Intrarenal Surgery (RIRS) emerging as minimally invasive alternatives to traditional Pyelolithotomy. This study aims to assess the effectiveness of Mini-PCNL and RIRS for renal stones measuring 1-2 cm, focusing on operative time, stone clearance, hospital stay, and the need for ancillary procedures.

**Methodology:** This retrospective study collected data from the medical records of patients admitted to The Department of Urology at The Kidney Centre, Karachi, between January 1, 2021, and August 31, 2022. The study included 100 patients who underwent RIRS and 129 patients who underwent Mini-PCNL.

**Results:** It was found that the operative time was statistically similar in both groups. However, the length of hospital stay was significantly higher in the Mini-PCNL group (more than 2 days in 88.4%), whereas in the RIRS group, the majority of patients stayed ≤ 2 days (78%). Overall stone clearance was 82.1%, with a slightly higher clearance rate in patients who underwent Mini-PCNL (85.3%) compared to RIRS (78%), though the p-value was not statistically significant.

**Conclusion:** For renal stones sized 1-2 cm, both RIRS and Mini-PCNL demonstrate efficient treatment options with comparable stone-free rates. RIRS appears more comfortable and less morbid than Mini-PCNL, with a shorter hospital stay. Although Mini-PCNL requires an extended hospital stay to treat 1- to 2-cm renal stones, it is associated with fewer complications and a reduced need for a JJ stent, making it a viable alternative to RIRS in certain cases.

## Keywords

Mini Percutaneous Nephrolithotomy, Retrograde Intrarenal Surgery, Renal Stones, Ureteroscopy.

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## Introduction

The global prevalence of kidney stones has steadily increased, reaching an estimated 7.2-7.7%. This upward trend, observed across both genders since the last quarter of the 20th century, highlights the substantial impact of kidney stone disease on individuals, healthcare systems, and society at large[1].

The landscape of renal stone management has undergone a transformative shift in recent decades, thanks to the introduction of minimally invasive tools and techniques. In 1976, Johanson and Fernstrom pioneered percutaneous stone removal under fluoroscopic guidance, marking a groundbreaking development. Since then, this technique has been refined and miniaturized, giving rise to various procedures for treating renal stones. To mitigate invasiveness approaches such as Mini Percutaneous Nephrolithotomy (Mini PCNL, <22 Fr), Ultra-Mini PCNL (11-13Fr), and Micro PCNL (4.8 Fr) have been employed[2].

Technological advancements have played a crucial role in the evolution of renal stone management. Ureteroscopy, introduced by Marshall in 1964, has undergone significant improvements, especially between 1980 and 1990, with enhancements in fiber optics for superior image relay and light transmission. Further miniaturization of components, such as the outer diameter, working channel, and deflections, has enabled more versatile movements. The shift to digital imaging systems after 2000 has substantially improved image quality[3].

In 2019, Zhao et al. compared Mini PCNL with RIRS, reporting Mini PCNL's superiority in stone-free rate (93.3% vs. 66%) and complications (8.5% vs. 12.2%). However, RIRS demonstrated a statistically significant shorter hospital stay ($p<0.001$)[4].

Conversely, a 2021 study by Coskun et al. presented nuanced results, finding no substantial differences in the stone-free rate and operative time between Mini PCNL and RIRS. However, they did note higher complication rates and an extended hospital stay associated with Mini PCNL[5].

Our study aims to meticulously analyze Mini PCNL and RIRS concerning operative time, stone-free rate, the necessity for ancillary procedures, and complications. Moreover, we aim to advocate for a paradigm shift in our country's current treatment practices, where many surgeons still favor Pyelolithotomy over less invasive approaches like PCNL and RIRS, practices no longer recommended in the modern medical landscape.

## Methodology

A retrospective study was conducted at The Kidney Centre Post Graduate Training Institute in Karachi, Pakistan, focusing on 229 patients who underwent kidney stone surgery between January 1, 2021, and August 31, 2022. These patients were categorized into two groups based on the type of surgery received: the first group comprised 100 patients who underwent RIRS, and the second group included 129 patients who underwent Mini-PCNL.

A comprehensive proforma was meticulously designed to collect patient-specific demographic information, encompassing age, gender, stone location, number and size of stones, operative time, hospital stay, DJ insertion, the necessity for ancillary procedures, and post-operative complications. To uphold patient confidentiality, unique study codes replaced all medical record numbers, and access to the original data was restricted to the Primary Investigator. Throughout data collection and review, no direct interaction occurred with the patients.

This study included individuals of both genders, aged 16 to 60 years, with renal stones ranging from 1 to 2 centimeters. Exclusions comprised those aged ≤16 or ≥60 years, patients with renal stones <1 cm or >2 centimeters, those with a history of Pyelolithotomy, known chronic kidney disease (CKD), pregnant women, individuals with bleeding disorders or uncorrected coagulopathy, untreated urinary tract infections (UTIs), musculoskeletal abnormalities, and those with a solitary functioning kidney.

On the first postoperative day, an X-ray KUB was conducted to confirm DJ stent placement and

assess stone clearance. One-month post-surgery, ultrasonography was performed, with stone-free status determined by the absence of any remaining fragments. Residual stones measuring ≤4 mm was considered clinically insignificant residual fragments (CIRF).

Data entry, cleaning, coding, and analysis were performed using IBM SPSS version 26. Continuous variables were expressed as mean ± SD, while categorical variables were presented as frequency with percentages.

Associations between categorical parameters were assessed using the Chi-square test, and differences in continuous variables were evaluated using the student t-test. The normality of continuous variables was verified using the Shapiro-Wilk test, with a significance level set at $p \leq 0.05$.

## Results

The study included 229 patients, with 56.3% in the Mini PCNL group and 43.7% in the RIRS group. The mean age of the patients was 42.3 ± 13.6 years. A male preponderance was noted in the RIRS group (68%) compared to the Mini PCNL group (51.9%) (p=0.014). Additionally, patients with multiple stones were more frequent in the RIRS group (64%) than in the Mini PCNL group (p=0.003). Statistically significant differences were also observed in the size of stones between the two groups (p=0.008). The prevalence of stones sized 1-1.5 cm was higher in the RIRS group compared to the Mini PCNL group (70% vs. 52.7%) (Table 1).

**Table 1: Comparison of baseline characteristics of the enrolled patients.**

| Variables | | Procedure | | Total (n=229) | P- value |
|---|---|---|---|---|---|
| | | Mini PCNL [N=129(56.3%)] | RIRS [N=100(43.7%)] | | |
| **Age in years (Mean ± SD)** | | 41.8 ± 12.8 | 42.9 ± 14.6 | 42.3 ± 13.6 | 0.540 |
| **Gender** | Male | 67(51.9) | 68(68.0) | 139(59.0) | 0.014* |
| | Female | 62(48.1) | 32(32.0) | 94(41.0) | |
| **Site of stone** | Right | 71(55) | 48(48.0) | 119(52.0) | 0.104 |
| | left | 19(14.7) | 26(26.0) | 45(19.7) | |
| | Bilateral | 39(30.2) | 26(26.0) | 65(28.4) | |
| **Number of stones** | Single | 65(50.4) | 36(36.0) | 101(44.1) | 0.030* |
| | Multiple | 64(49.6) | 64(64.0) | 128(55.9) | |
| **Size of stone** | 1-1.5 cm | 68(52.7) | 70(70.0) | 138(60.3) | 0.008* |
| | 1.6-2 cm | 61(47.3) | 30(30.0) | 91(39.7) | |

*p<0.05 is considered significant.

Operative time was statistically similar between both groups (p=0.89). However, the length of hospital stays showed a highly significant difference (p 2 days (88.4%), while in the RIRS group, most patients stayed ≤ 2 days (78%). The choice of procedure was also associated with the insertion of a DJ stent (p<0.001). DJ stenting was more commonly performed in patients undergoing RIRS (86%) than those undergoing Mini PCNL (27.9%). Overall, a limited number of ancillary procedures were observed in the patient cohort (18.3%), with a nearly equal distribution in both groups (p=0.566). Similarly, a low incidence of complications (7.4%) was recorded, and these complications were evenly distributed between the two procedural groups (p=0.77) (Table 2).

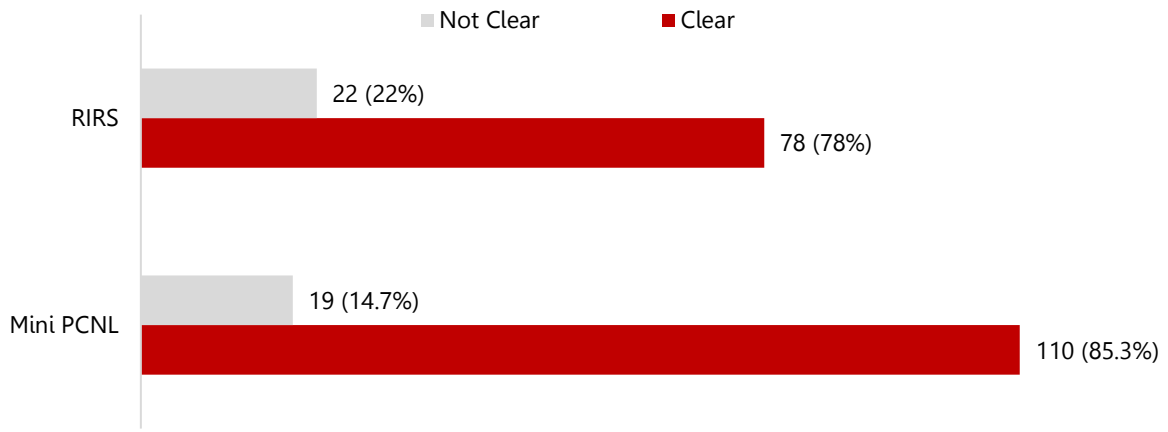


**Figure 1: Comparison of complete clearance of stone in two groups.**

Our analysis revealed an overall complete stone clearance of 82.1% among the study participants. Notably, patients who underwent the Mini PCNL procedure exhibited a higher stone clearance rate (85.3%) compared to those who underwent RIRS (78%), although the p-value did not reach significance (p=0.155) (Figure 1).

Further stratification of variables by surgical procedures showed comparable rates of complete stone removal for both sizes of stones in the Mini PCNL group (85.3% vs. 85.2%). In contrast, within the RIRS group, stone removal was slightly more successful for smaller stones (1-1.5 cm) compared to larger stones (1.6-2 cm) (78.6% vs. 76.7%), although the difference was not statistically significant (p=0.837). These findings suggest a trend favoring Mini PCNL in achieving a higher overall stone clearance rate, emphasizing its potential as an effective treatment option for renal stones in the specified size range.

**Table 2: Comparison of pre-operative and post-operative variables between the two groups of patients.**

| Variables | | Procedure [n(%)] | | P- value |
|---|---|---|---|---|
| | | Mini PCNL | RIRS | |
| **Operative time** | ≤ 1 hour | 53(41.1) | 38(38.0) | 0.890 |
| | >1-2 hours | 56(43.2) | 46(46.0) | |
| | > 2 hours | 20(15.5) | 16(16.0) | |
| **Hospital stay** | Daycare | - | 8(8.0) | <0.001* |
| | ≤ 2 days | 15(11.6) | 78(78.0) | |
| | > 2 days | 114(88.4) | 14(14.0) | |
| **Insertion of DJ stent** | Yes | 36(27.9) | 86(86.0) | <0.001* |
| | No | 93(72.1) | 14(14.0) | |
| **Ancillary procedure** | Yes | 22(17.1) | 20(20.0) | 0.568 |
| | No | 107(82.9) | 80(80.0) | |
| **Complications** | Yes | 9(7.0) | 8(8.0) | 0.770 |
| | No | 120(93.0) | 92(92.0) | |

*p<0.05 is considered significant.

In the Mini PCNL group, complete removal of single stones was achieved in 90.8% of cases, whereas the clearance rate for multiple stones was slightly lower at 79.9% (p=0.076). In contrast, within the RIRS group, the

clearance of single stones was notably higher at 94.4%, whereas the clearance rate for multiple stones was 68.8% (p=0.003) (Table 3).

**Table 3: Effect of variables on the clearance of stone stratified by the two procedures of surgery.**

| Variables | | Complete clearance of stone | | P-value |
|---|---|---|---|---|
| **Size of stone** | | **Yes [n=188(82.1%)]** | **No [n=41(17.9%)]** | |
| Mini PCNL | 1-1.5 cm | 58(85.3) | 10(14.7) | 0.994 |
| | 1.6-2 cm | 52(85.2) | 9(14.8) | |
| RIRS | 1-1.5 cm | 55(78.6) | 15(21.4) | 0.837 |
| | 1.6-2 cm | 23(76.7) | 7(23.3) | |
| **Number of stones** | | | | |
| Mini PCNL | Single | 59(90.8) | 6(9.2) | 0.076 |
| | Multiple | 51(79.7) | 13(20.3) | |
| RIRS | Single | 34(94.4) | 2(5.6) | 0.003* |
| | Multiple | 44(68.8) | 20(31.3) | |

PCNL-Percutaneous Nephrolithotomy, RIRS-Retrograde Intrarenal Surgery
*p<0.05 is considered significant.

## Discussion

Small renal stones offer various treatment options, such as ESWL, RIRS, and PCNL/Mini PCNL. As per the European Association of Urology guidelines, ESWL is the favored first-line treatment for renal stones smaller than 2 cm, situated in the renal pelvis, upper or middle calyces. Nevertheless, when the stones are located in the lower pole, the guidelines suggest using PCNL or RIRS, as the efficacy of ESWL in this location is limited[6].

In recent times, less invasive procedures like ESWL, PCNL, and RIRS have become the preferred alternatives to open surgery for treating renal calculi in both adults and children. Initially endorsed in the 1980s as the primary treatment for stones smaller than 20 mm, its adverse effect on renal parenchyma and surrounding organs also needs multiple ESWL sessions for stiffer stones to decrease efficacy[7].

The success rate is the most crucial parameter representing the effectiveness of operational techniques used to treat renal stones. PCNL (24-30 F) is the gold standard for large-volume stones and provides a higher stone-free rate than RIRS and ESWL. However, the main issue with PCNL is the higher complication rate. However, the introduction of Mini PCNL has helped to reduce this complication rate[8].

With an immense improvement in the technology of flexible Ureteroscopy, RIRS is now more frequently used. The developments in deflection mechanism, mobility, ergonomics, and durability of equipment have also contributed to the increased use of RIRS. In addition, with the development of auxiliary devices such as miniaturized holmium laser fibers, nitinol baskets, guidewires, and ureteral access sheaths, and an increase in surgical experience, higher success rates have been achieved in the management of kidney stones with RIRS[9].

Fayad et al. reported longer operative time for RIRS than Mini-PCNL with a significant p<0.001[10], but Sabnis et al. reported shorter operative time in the RIRS group compared to Micro PCNL[11]. However, in our study, there was no statistically significant difference in operative time between the two groups (Mini PCNL vs RIRS) (p=0.89); this differs from the findings in both studies.

Mustafa et al. conducted a study that found a significantly shorter hospital stay for patients who

underwent RIRS compared to Mini PCNL[12]. Our study produced similar results, with the RIRS group having a shorter hospital stay than the mini PCNL group, with a significant p-value<0.001.

Fayad et al. found a higher stone-free rate for mini PCNL than RIRS (92.72% vs. 84.31%). The difference was not statistically significant[10]. Based on our result analysis, the complete stone clearance rate among the patients who underwent the Mini PCNL was higher at 85.3%, compared to 78% for those who underwent RIRS. However, the p-value was insignificant despite this difference (p=0.155).

In our study, only 22 out of 129 patients in the mini PCNL group required ancillary procedures, while in the RIRS group, this was limited to 20 out of 100 patients. However, the difference was not statistically significant, as indicated by a p-value of 0.568.

In summary, our study did not find significant differences in operative time but did confirm shorter hospital stays for RIRS patients. While there was a higher stone clearance rate in the Mini PCNL group, this difference was not statistically significant. The need for ancillary procedures did not significantly differ between the two groups. These findings provide insights into the effectiveness of Mini PCNL and RIRS for treating renal stones of 1-2 cm.

Although our study provides valuable insights into the effectiveness of Mini PCNL and RIRS for renal stones in the specified size range, it is advisable to conduct additional research and comparative studies in diverse settings to further improve the applicability of these findings

## Study Limitations

The primary limitation of our study is its relatively small sample size, which may restrict the generalizability and broader implications of our findings. A larger-scale study could offer more robust and widely applicable insights into the comparative effectiveness of Mini PCNL and RIRS. However, it is crucial to acknowledge the practical challenges of conducting extensive studies, particularly when dealing with procedures like RIRS, which can be cost-prohibitive. Balancing the need for a larger sample size with the financial constraints of certain procedures underscores the inherent challenges in research endeavors. Future research with increased sample sizes and potentially collaborative efforts across multiple institutions could help address these limitations and enhance the robustness of the study's outcomes.

## Conclusion

In managing 1-2 cm renal stones, both RIRS and Mini-PCNL demonstrate efficiency with comparable stone-free rates. Notably, RIRS emerges as a more comfortable and less morbid option when compared to Mini-PCNL. Our study also concludes that RIRS is associated with a shorter hospital stay than Mini-PCNL. While Mini-PCNL requires a prolonged hospital stay to treat 1-2 cm renal stones, it offers advantages such as a reduced need for a JJ stent and nearly identical complication rates compared to RIRS. These findings contribute valuable insights for clinicians when considering the optimal treatment approach for patients with renal stones in the specified size range. Further research and long-term follow-up studies are warranted to refine our understanding of these minimally invasive procedures' comparative benefits and drawbacks.

## Conflicts of Interest

The authors declare no conflicts of interest.

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