



Original Article

## Comparative Study Between Percutaneous Nephrolithotomy (Pcnl) and Retrograde Intrarenal Surgery (RIRS) for Management of Renal Calculi

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### ABSTRACT

**Background:** Renal calculi are among the most common urological disorders and are associated with significant morbidity. Percutaneous Nephrolithotomy (PCNL) and Retrograde Intrarenal Surgery (RIRS) are widely used minimally invasive procedures for the management of renal stones. However, the optimal treatment approach for renal calculi remains a matter of debate.

**Objectives:** To compare the efficacy, safety, and perioperative outcomes of PCNL and RIRS in the management of renal calculi.

**Materials and Methods:** This prospective comparative study was conducted in the Department of Urology, Mahadevappa Rampure Medical College, Kalaburagi, from January 2021 to July 2021. A total of 150 patients diagnosed with renal calculi were included and divided into two groups: PCNL (n=75) and RIRS (n=75). Demographic characteristics, stone-related parameters, operative time, hospital stay, haemoglobin drop, postoperative pain, stone-free rate, complications, and recovery outcomes were evaluated and compared. Statistical analysis was performed using appropriate tests, and a p-value <0.05 was considered statistically significant.

**Results:** The mean age of patients was comparable between the PCNL and RIRS groups (43.8 ± 11.2 vs. 42.6 ± 10.8 years; p=0.51). The stone-free rate was significantly higher in the PCNL group than in the RIRS group (94.7% vs. 85.3%; p=0.048). Operative time was significantly shorter with PCNL (86.4 ± 15.7 minutes) compared with RIRS (102.8 ± 18.3 minutes; p<0.001). However, RIRS was associated with significantly shorter hospital stay (2.1 ± 0.7 vs. 3.9 ± 1.1 days; p<0.001), lower hemoglobin drop (0.62 ± 0.31 vs. 1.46 ± 0.52 g/dL; p<0.001), lower postoperative pain scores (3.4 ± 0.9 vs. 5.2 ± 1.1; p<0.001), and earlier return to normal activities (6.3 ± 1.9 vs. 10.4 ± 2.8 days; p<0.001). Blood transfusion requirement was significantly higher in the PCNL group (5.3% vs. 0%; p=0.04).

**Conclusion:** Both PCNL and RIRS are safe and effective treatment options for renal calculi. PCNL offers superior stone clearance and remains the preferred treatment for larger stones, whereas RIRS provides advantages in terms of reduced blood loss, lower postoperative pain, shorter hospitalisation, and faster recovery. Treatment selection should be individualised based on stone characteristics and patient-related factors.

**Keywords:** Renal calculi; Percutaneous nephrolithotomy; Retrograde intrarenal surgery; PCNL; RIRS; Stone-free rate; Urolithiasis.

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### INTRODUCTION

Urolithiasis is one of the most common urological disorders worldwide and represents a significant burden on healthcare systems. The prevalence of urinary stone disease has increased substantially over the past few decades due to changes in dietary habits, obesity, metabolic syndrome, sedentary lifestyle, and environmental factors. Renal calculi account for a major proportion of urinary tract stones and are associated with considerable morbidity including severe flank pain, hematuria, urinary tract infections, obstruction, and impaired renal function if left untreated (1,2).

The management of renal calculi has undergone remarkable transformation with the advent of minimally invasive surgical techniques. Traditionally, open stone surgery was the standard treatment modality; however, advances in endourology have largely replaced open procedures with less invasive approaches such as extracorporeal shock wave lithotripsy (ESWL), Percutaneous Nephrolithotomy (PCNL), and Retrograde Intrarenal Surgery (RIRS) (3).

PCNL, first introduced by Fernström and Johansson in 1976, is currently regarded as the gold standard treatment for renal stones larger than 2 cm. The procedure provides direct access to the renal collecting system, enabling efficient fragmentation and removal of stone material with excellent stone-free rates. Nevertheless, PCNL is associated with certain disadvantages, including bleeding, postoperative pain, longer hospitalization, and potential injury to adjacent organs (4,5).

RIRS has emerged as an increasingly popular alternative owing to technological advancements in flexible ureteroscopy, digital imaging systems, and Holmium laser lithotripsy. RIRS allows treatment of intrarenal stones through a natural orifice approach without the need for percutaneous access. The procedure is associated with reduced blood loss, lower postoperative morbidity, shorter hospital stay, and faster recovery. However, concerns remain regarding lower stone-free rates and the potential requirement for multiple treatment sessions, especially in patients with larger stone burdens (6,7). Although both PCNL and RIRS are widely accepted treatment options for renal calculi, the optimal approach for stones measuring 1–3 cm remains a subject of ongoing debate. Therefore, the present study was undertaken to compare the efficacy, safety, perioperative outcomes, and complications associated with PCNL and RIRS in patients undergoing surgical management of renal calculi at a tertiary care centre.

## **MATERIALS AND METHODS**

### **Study Design and Setting**

This prospective comparative study was conducted in the Department of Urology, Mahadevappa Rampure Medical College and Teaching Hospital, Kalaburagi, Karnataka, India, from January 2021 to July 2021.

### **Study Population**

A total of 150 patients diagnosed with renal calculi and requiring surgical intervention were enrolled in the study. Patients were allocated into two groups based on the surgical procedure performed:

- **Group A (PCNL Group):** 75 patients underwent Percutaneous Nephrolithotomy (PCNL).
- **Group B (RIRS Group):** 75 patients underwent Retrograde Intrarenal Surgery (RIRS).

### **Inclusion Criteria**

- Patients aged 18 years and above.
- Patients diagnosed with renal calculi measuring 1–3 cm in size.
- Patients fit for surgical intervention under anaesthesia.
- Patients who provided informed written consent for participation.

### **Exclusion Criteria**

- Patients with uncorrected coagulopathy.
- Pregnant women.
- Patients with active urinary tract infection not responding to treatment.
- Patients with congenital renal anomalies.
- Patients with severe cardiopulmonary comorbidities contraindicating surgery.
- Patients unwilling to participate in the study.

### **Preoperative Evaluation**

All patients underwent detailed clinical assessment, including medical history and physical examination. Baseline investigations included complete blood count, renal function tests, serum electrolytes, coagulation profile, urine routine examination, urine culture and sensitivity, ultrasonography of the kidney-ureter-bladder region, and non-contrast computed tomography (NCCT) of the abdomen and pelvis for stone characterization.

### **Surgical Procedure**

#### **Percutaneous Nephrolithotomy (PCNL)**

PCNL was performed under general or spinal anesthesia. Percutaneous renal access was obtained under fluoroscopic guidance. Tract dilatation was carried out, followed by nephroscopy and stone fragmentation using pneumatic or ultrasonic lithotripsy. Stone fragments were extracted, and a nephrostomy tube was placed when indicated.

## Retrograde Intrarenal Surgery (RIRS)

RIRS was performed under general anesthesia using a flexible ureteroscope. Following placement of a ureteral access sheath, stones were fragmented using a Holmium laser. Stone dusting or fragmentation techniques were employed according to stone characteristics. A double-J stent was placed at the end of the procedure when required.

### Outcome Measures

The following parameters were evaluated and compared between the two groups:

- Operative time (minutes)
- Stone-free rate
- Length of hospital stay (days)
- Intraoperative complications
- Postoperative complications
- Hemoglobin drop
- Requirement for blood transfusion
- Need for auxiliary procedures
- Postoperative pain scores
- Time to return to normal activities

Stone-free status was assessed using ultrasonography and/or NCCT at follow-up and defined as complete clearance or clinically insignificant residual fragments less than 4 mm.

### Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between the two groups were performed using the Student's t-test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. A p-value  $<0.05$  was considered statistically significant.

## RESULTS AND OBSERVATIONS;

A total of 150 patients with renal calculi were included in the study, comprising 75 patients who underwent Percutaneous Nephrolithotomy (PCNL) and 75 patients who underwent Retrograde Intrarenal Surgery (RIRS). The demographic characteristics of both groups were comparable at baseline.

**Table 1: Demographic Characteristics of Study Participants**

Variable	PCNL (n=75)	RIRS (n=75)	p-value
Mean Age (years)	43.8 $\pm$ 11.2	42.6 $\pm$ 10.8	0.51
Male	48 (64.0%)	46 (61.3%)	0.73
Female	27 (36.0%)	29 (38.7%)	
BMI (kg/m <sup>2</sup> )	24.9 $\pm$ 3.4	24.5 $\pm$ 3.2	0.46

Both groups were comparable with respect to age, sex distribution, and body mass index.

**Table 2: Stone Characteristics**

Variable	PCNL (n=75)	RIRS (n=75)	p-value
Mean Stone Size (cm)	2.32 $\pm$ 0.41	2.25 $\pm$ 0.39	0.29
Lower Calyx Stones	26 (34.7%)	29 (38.7%)	0.61
Pelvic Stones	31 (41.3%)	28 (37.3%)	0.62
Multiple Stones	18 (24.0%)	18 (24.0%)	1.00

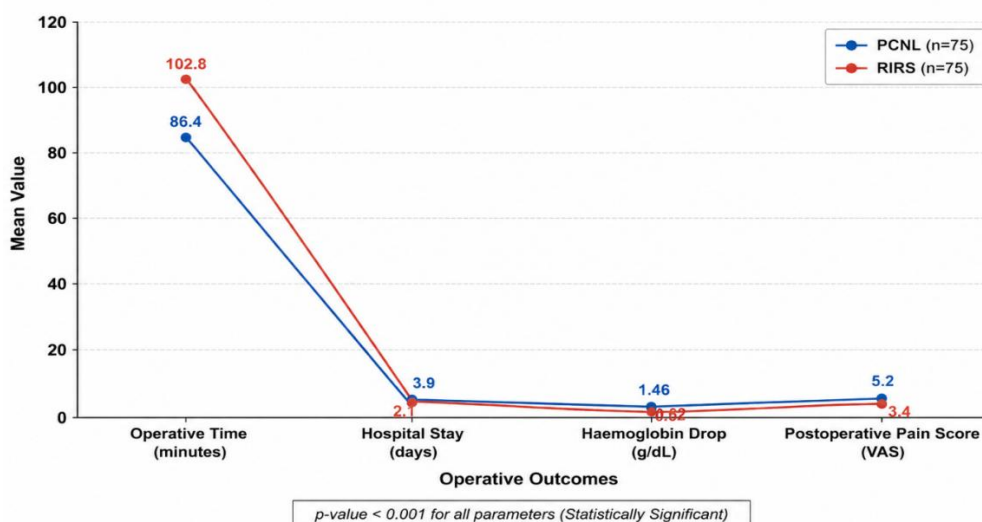
No significant difference was observed in stone size or stone location between the groups.

**Table 3: Comparison of Operative Outcomes**

Parameter	PCNL (n=75)	RIRS (n=75)	p-value
Operative Time (minutes)	86.4 $\pm$ 15.7	102.8 $\pm$ 18.3	$<0.001$
Hospital Stay (days)	3.9 $\pm$ 1.1	2.1 $\pm$ 0.7	$<0.001$
Haemoglobin Drop (g/dL)	1.46 $\pm$ 0.52	0.62 $\pm$ 0.31	$<0.001$
Postoperative Pain Score (VAS)	5.2 $\pm$ 1.1	3.4 $\pm$ 0.9	$<0.001$

Operative time, haemoglobin drop, postoperative pain score, and hospital stay were significantly higher in the PCNL group.

### Comparison of Operative Outcomes Between PCNL and RIRS



**Table 4: Stone-Free Rate and Auxiliary Procedures**

Outcome	PCNL (n=75)	RIRS (n=75)	p-value
Stone-Free Rate	71 (94.7%)	64 (85.3%)	0.048
Residual Stones	4 (5.3%)	11 (14.7%)	
Auxiliary Procedure Required	3 (4.0%)	10 (13.3%)	0.038

The stone-free rate was significantly higher in the PCNL group, whereas auxiliary procedures were more frequently required following RIRS.

**Table 5: Postoperative Complications**

Complication	PCNL (n=75)	RIRS (n=75)	p-value
Fever	8 (10.7%)	5 (6.7%)	0.38
Hematuria Requiring Intervention	5 (6.7%)	1 (1.3%)	0.09
Blood Transfusion	4 (5.3%)	0 (0%)	0.04
Urinary Tract Infection	6 (8.0%)	4 (5.3%)	0.51
Overall Complications	18 (24.0%)	10 (13.3%)	0.09

Blood transfusion requirement was significantly higher in the PCNL group. Other complications were comparable between groups.

**Table 6: Time to Return to Normal Activities**

Parameter	PCNL (n=75)	RIRS (n=75)	p-value
Return to Normal Activities (days)	10.4 ± 2.8	6.3 ± 1.9	<0.001

Patients undergoing RIRS resumed normal daily activities significantly earlier than those undergoing PCNL.

## DISCUSSION

The present study evaluated and compared the clinical outcomes of Percutaneous Nephrolithotomy and Retrograde Intrarenal Surgery in the management of renal calculi. Both procedures demonstrated favorable outcomes; however, significant differences were observed in stone clearance, perioperative morbidity, and postoperative recovery.

In the present study, the stone-free rate was significantly higher in the PCNL group (94.7%) compared with the RIRS group (85.3%). This finding is consistent with the study conducted by Akman et al. (8), who reported superior stone clearance following PCNL for renal stones larger than 2 cm. Similarly, De et al. (9), in a systematic review and meta-analysis, concluded that PCNL provides higher stone-free rates compared with RIRS, particularly in patients with large and complex renal calculi. The superior efficacy of PCNL can be attributed to direct access to the renal collecting system, allowing complete fragmentation and extraction of stone fragments during a single procedure.

The mean operative time in the present study was significantly shorter in the PCNL group compared with the RIRS group. Similar observations have been reported by Bryniarski et al. (10), who found that laser lithotripsy and fragmentation during RIRS may prolong operative duration, especially when treating stones larger than 2 cm. Although advances in laser technology have improved procedural efficiency, RIRS may still require longer operating times because complete stone dusting can be time-consuming.

A significant advantage of RIRS observed in the present study was the shorter duration of hospital stay. Patients undergoing RIRS required significantly fewer days of hospitalization compared with those treated by PCNL. These findings are comparable to those reported by Akman et al. (11), who demonstrated that the minimally invasive nature of RIRS facilitates early mobilization and discharge. Reduced hospital stay not only improves patient satisfaction but also decreases healthcare costs.

The mean hemoglobin drop was significantly greater in the PCNL group. Furthermore, all blood transfusions occurred in patients undergoing PCNL. These findings are in agreement with those of Kukreja et al. (12), who identified renal puncture and tract dilatation as major contributors to bleeding during PCNL. In contrast, RIRS utilizes a natural orifice approach and therefore minimizes renal parenchymal trauma and blood loss.

Postoperative pain scores were significantly lower among patients treated with RIRS. Similar findings have been reported by Resorlu et al. (13), who observed improved postoperative comfort and reduced analgesic requirements following RIRS. The absence of a nephrostomy tract and reduced tissue injury likely account for the lower pain scores observed in the RIRS group.

The present study also demonstrated significantly earlier return to normal activities among patients undergoing RIRS. This finding is clinically important because rapid recovery and shorter convalescence periods are increasingly valued by patients. Giusti et al. (14) similarly reported that RIRS offers faster functional recovery compared with PCNL owing to its minimally invasive nature.

Regarding complications, fever and urinary tract infections occurred in both groups without significant differences. Although overall complications were more frequent following PCNL, major complications were uncommon in both groups. Seitz et al. (15) reported comparable findings and concluded that both procedures have acceptable safety profiles when performed by experienced surgeons with appropriate perioperative management.

The requirement for auxiliary procedures was significantly higher among patients undergoing RIRS. This observation is likely related to residual stone fragments and the lower initial stone-free rate. Several previous studies have demonstrated that larger stones treated with RIRS may require staged procedures to achieve complete clearance, whereas PCNL often provides definitive treatment in a single session (9,10).

The findings of the present study suggest that PCNL remains the preferred treatment modality for achieving maximum stone clearance, particularly in larger renal calculi. Conversely, RIRS offers important advantages in terms of reduced blood loss, lower postoperative pain, shorter hospitalization, and faster return to routine activities. Therefore, the choice between PCNL and RIRS should be individualized based on stone characteristics, patient comorbidities, surgeon expertise, and patient preference.

## CONCLUSION

Both Percutaneous Nephrolithotomy (PCNL) and Retrograde Intrarenal Surgery (RIRS) are safe and effective treatment modalities for the management of renal calculi. PCNL provides a significantly higher stone-free rate and remains the preferred option for larger renal stones. In contrast, RIRS is associated with lower blood loss, reduced postoperative pain, shorter hospital stay, and faster recovery. Therefore, the choice of procedure should be individualised based on stone characteristics, patient factors, and surgeon expertise to achieve optimal clinical outcomes.

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