Original Article

# Is percutaneous nephrolithotomy safe in chronic kidney disease patients!!!

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## Abstract

**Introduction:** Management of renal calculus in a patient of chronic kidney disease (CKD) is always challenging. Treatment options include extracorporeal shock wave lithotripsy, retrograde intrarenal surgery, and percutaneous nephrolithotomy (PCNL). With PCNL being gold standard for renal calculus ≥1.5 cm in normal kidneys, we aimed to analyze the safety and efficacy of PCNL in CKD patients with calculus ≥1.5 cm.

**Materials and Methods:** Sixty patients of CKD with renal calculus were included in the study: Group A with glomerular filtration rate (GFR) ≤30 ml/min/m$^2$ and Group B with GFR >30 <60 ml/min/m$^2$. The estimated GFR (eGFR) pre-PCNL, peak eGFR on follow-up, and eGFR at last follow-up, stone free rates, and complications were recorded. The CKD stage before and after PCNL were also compared at the last follow-up.

**Results:** The mean age of patients was 52 years. A mean of 1.14sittings per renal unit was required for PCNL. Complete clearance was 94% after all auxiliary procedures. The mean prePCNL eGFR was 26.5 ± 4.01 and 43.6 ± 9l. 14 ml/min/1.73 m$^2$ in Groups A and B, respectively. The mean post-PCNL eGFR was 32 ± 9.94 and 51 ± 8.85 ml/minute/1.73 m2, respectively, in Groups A and B. At a mean follow-up of 180 days, deterioration with the migration of CKD stage was seen in 13 patients (21.6%) out of which 10 patients were of Groups A and 3 in Group B. Six patients (10%) required maintenance hemodialysis. Postoperative bleeding complication requiring blood transfusions was seen in 12 (20%) and 3 (5%) required intensive care unit care postoperatively. No mortality was observed in our study.

**Conclusion:** PCNL is an effective management strategy for renal calculus in patients with CKD with an acceptable stone clearance rates and manageable complications. Peak eGFR <30 ml/min/m2 and postprocedure complications predict deterioration and need for RRT.

**Keywords:** Chronic kidney disease, complications, estimated glomerular filtration rate, percutaneous nephrolithotomy

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## INTRODUCTION

Urinary stone disease is a recognized precursor for renal deterioration. Chronic kidney disease (CKD) is a major public health problem with the incidence of stone disease being 0.8% to 17.5%. CKD patients in surgical setting are at higher risk of anesthetic as well as postprocedure complications.[1,2] Managing CKD with nephrolithiasis is a challenging task for both endourologists and nephrologists,

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and calls for careful consideration of the benefit risk ratio.[3-5] The main aim of surgical interventions employed in the treatment of stone disease is to preserve maximal renal function with other aims being pain alleviation, removing nidus for recurrent calculus formation, and preventing urinary tract infections. Management of renal calculi in CKD patients includes various treatment options such as extracorporeal shock wave lithotripsy (ESWL), retrograde intrarenal surgery (RIRS), laparoscopy or percutaneous nephrolithotomy (PCNL). PCNL provides single-step maximum stone clearance even on huge stone burden with poorly functioning kidney. However, wide range of complications especially bleeding and acute/chronic detoriation of renal function limits its widespread use. Evidence is scarce regarding the complications and outcomes of PCNL in CKD patients. Hence, here, we conducted a study to analyze demography, the factors that can impair renal function, complications, and postoperative outcomes in patients with Stages III, IV, and V CKD, undergoing PCNL.

## MATERIALS AND METHODS

A total of 552 consecutive PCNLs were done for renal calculi at our institution from September 2012 to August 2018. 60 (10%) patients sufficed inclusion criteria with stone size ≥1.5 cm Figure 1. Patients with bleeding diathesis, pregnancy, or poor on follow-up were excluded from the study. We used a 4-variable Modification of Diet in Renal Disease (MDRD) equation to calculate estimated glomerular filtration rate eGFR of each patient.[6] CKD was further classified using the National Kidney Foundation Kidney Disease Outcome Quality Initiative classification system.[7] Patients were divided into two groups, Group A with GFR less than or equal to 30 ml/min/$m^2$ and Group B with GFR >30 <60 ml/min/$m^2$. Patients demographic parameters, kidneys, ureters, bladder (X-KUB), computed tomography (CT) KUB findings, routine blood, and urine analysis reports were noted. All patients underwent PCNL by standard C-Arm guided approach, using Bull's eye technique.[8] Patients were followed up for a period of 6 months. The pre-PCNL eGFR and eGFR at last follow-up were recorded and analyzed.

### Technique

PCNL access was achieved under C-arm fluoroscopy using an 18 gauge needle with the patient prone after placing a ureteric catheter.[9] The access tract was dilated using a serial coaxial Amplatz dilator up to 24 Ch. The stones fragmentation was done using a pneumatic lithotriptor. Intraoperatively operative time and any complications if occured were noted. Additional tracts were created during the same session or multiple sessions as indicated. An 20 Fr nephrostomy tube was placed at the end of all cases. We placed a double J stent (DJS) after PCNL in all patients except in a few with a single stone and no intraoperative complications like pelvicalyceal perforation. The median time to nephrostomy removal was 3.1 days (range 1–5), and DJS was removed at 4 weeks. Postoperatively patients were assessed for any complications, bleeding, need for hemodialysis.

Antibiotic prophylaxis was provided using third-generation cephalosporins, as per institute antibiotic policy. X-ray KUB and ultrasonography (USG)-KUB was done on day 1 after PCNL, for residual stones. The nephrostomy tube was removed on postoperative day (POD) 3 and patients were discharged on POD 4, if stable. Patients were studied 6 months postoperatively by urinalysis, serum creatinine measurement, X-ray KUB, USG KUB, and eGFR calculation. The effects of independent variables on kidney function after PCNL, including patient age, gender, need for blood transfusion stone-free status, need for auxillary procedures at 6-month post-PCNL, postoperative variables like mean hospital stay, need for Intensive care unit (ICU), eGFR pre-PCNL and at end of 6 months, were evaluated by comparing the groups. The Chi-square, Student's *t*-tests, and one-way ANOVA were used for analysis.

## RESULTS

Eighteen patients were included in Group A, out of which 10 are men and 8 women, while Group B had 42 patients of which 26 were men and 16 women. Mean age was 51.2 ± 11.8 years in Group A and 55 ± 15.2 years in Group B [Table 1]. Mean stone size was 1.82 cm. Left-sided (32) PCNL were done more commonly. 40 units had solitary renal calculus as compared to 15 units with multiple calculi and staghorn calculus was present in 12 units. Comorbidities associated with CKD included diabetes mellitus in 8 patients, hypertension in 32, both diabetes and hypertension in 10 patients. However, no comorbidity except urinary stone disease that might cause CKD was noted in 10 patients.

**Table 1: Patients demographics**

| Patient data | Total | Group A | Group B | *P* |
|---|---|---|---|---|
| CKD stage | | IV and V | III | |
| Number of patients | 60 | 18 | 42 | |
| Male | 36 | 10 | 26 | 0.282 |
| Female | 24 | 8 | 16 | |
| Mean age (years) | 52 | 55±15.2 | 51.2±11.8 | 0.324 |
| Side | 60 | | | |
| Left | 32 | 10 | 22 | 0.523 |
| Right | 28 | 8 | 20 | |

CKD: Chronic kidney disease

The mean eGFR pre-PCNL for Group A was 26.5 ± 4.01 ml/min/1.73 m$^2$ and Group B was 43.6 ± 9.14 ml/min/1.73 m$^2$ [Table 2]. Intraoperatively, mean 1.2 sittings were required in Group A as compared to 1.1 sitting in Group B. 9 patients in Group A required blood transfusion as compared to 3 patients in Group B ($P < 0.001$).

Total 12 out of 18 renal units had complete clearance in Group A as compared to 41 out of 42 in Group B. Postoperatively, three patients in Group A needed ICU stay as compared to none in Group B. 6 renal units in Group A underwent an auxiliary procedure for stone clearance as compared to 1 unit in Group B. Mean hospital stay was 5 ± 2.1 days in Group A as compared to 4 ± 1.2 days in Group B. At a mean follow-up of 180 days, post-PCNL eGFR was 32 ± 9.94 mL/min/1.73 m$^2$ in Group A and 51.3 ± 8.85 mL/min/1.73 m$^2$ in Group B ($P = 0.001$). Deterioration of renal function was seen in 13 patients out of which 10 patients were of Group A and 3 in Group B. six patients (10%) required Renal Replacement Therapy in the form of maintenance hemodialysis and all belonged to Group A ($P = 0.012$). There was no mortality in our study at a follow-up of 180 days in either of the group. Improved renal function was more often observed in patients with CKD who had concomitant disease as compared to those who did not.

On complications stratification as per CD classification more complications were observed on in Group 1 and Table 3. CD Grade 2,3 and 4 complications were significantly more in Group A. Group A also observed more CD Grade 1 complications, but statistically insignificant.

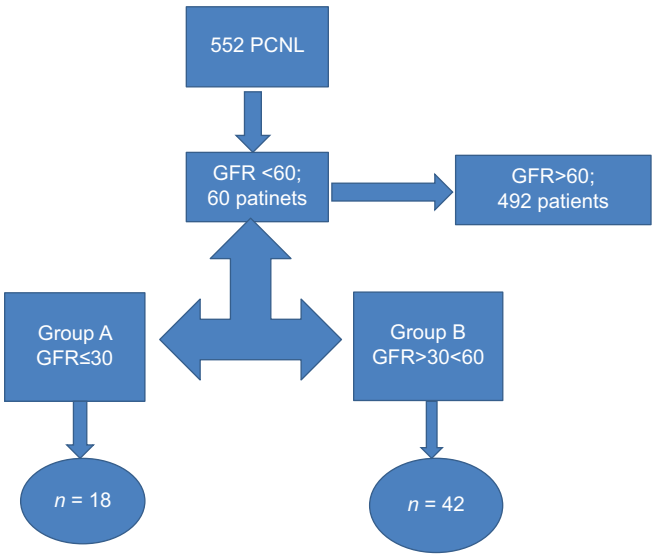


**Figure 1:** Sample collection

## DISCUSSION

Renal Calculi patients presenting with CKD are common in urologic practice. In the present era, wide array of noninvasive and minimally invasive surgical modalities are available for stone management including ESWL, RIRS, PCNL, laparoscopy, or robotic surgery. PCNL for renal calculi >2 cm is gold standard and its efficacy is well documented in literature. PCNL has highest single step success rate. However, the high success rate has concerns regarding serious complications such as bleeding, need for blood transfusion, fever, urinary tract infection, anesthesia-related complcations, ICU stay, and

**Table 2: Pre- and postoperative Indices of patients**

| Indices | Total | Group A | Group B | *P* |
|---|---|---|---|---|
| Intraoperative complications | | | | |
| Number of sittings | 1.17 | 1.21 | 1.1 | |
| Need for blood transfusion | 12 | 9 | 3 | <0.001 |
| Complete clearance (%) | 63 | 12 (66.66) | 34 (80.9) | 0.002 |
| Postoperative complications | | | | |
| Need for ICU | 3 | 3 | Nil | <0.001 |
| Auxiliary procedures | 7 | 6 | 1 | |
| Mean hospital stay (days) | 4.3 | 5±2.1 | 4±1.2 | 0.07 |
| Pre-PCNL GFR (ml/min/m$^2$) | 38.52±11.18 | 26.5±4.01 | 43.6±9.14 | <0.001 |
| GFR at follow-up (6 months) | 45.55±12.74 | 32±9.94 | 51.3±8.85 | <0.001 |
| Detoriation of renal function | 13 | 10 | 3 | 0.012 |
| Mean rise in GFR | | 6.67±7.7 | 8.02±7.2 | |
| Need for HD | 6 | 6 | Nil | <0.001 |
| Mortality | Nil | Nil | Nil | |

ICU: Intensive care unit, PCNL: Percutaneous nephrolithotomy, GFR: Glomerular filtration rate

**Table 3: Clavien-Dindo classification of postoperative complications**

| CD grade | Group A | Type | Group B | Type | *P* |
|---|---|---|---|---|---|
| Grade 1 | 3 | Fever-3 | 2 | Fever-2 | 0.154 |
| Grade 2 | 9 | Blood transfusion-9 | 3 | Blood transfusion-3 | <0.001 |
| Grade 3 | 6 | Auxillary procedure-6 | 2 | Auxillary procedure-2 | 0.007 |
| Grade 4 | 3 | ICU stay-3 | 0 | | 0.024 |
| Grade 5 | 0 | | 0 | | |

CD: Clavien-Dindo, ICU: Intensive care unit

**Table 4: Comparison with other studies**

| Variable | Kurien *et al*. | Kumar *et al*. | Canes *et al*. | Our study |
|---|---|---|---|---|
| Number of patients | 117 | 30 | 64 | 60 |
| Mean age | 52.5 | 45 | 60.7 | 52 |
| eGFR preoperative | 32.1 | 6.3 (serum creatinine) | 44.7 | 38.52 |
| eGFR postoperative | 43.3 | 2.8 (serum creatinine) | 55.4 | 45.55 |
| SFR (%) | 83.5 | 90 | | 80.9 |
| Auxillary procedure (%) | 2.5 | 10 | 8.7 | 11 |
| Complications (%) | 17 | 26.6 | 10.6 | 30 |
| Hospital stay (days) | | 10 | | 4.3 |

eGFR: Estimated glomerular filtration rate, SFR: Stone free rate

adjacent organ injury.[9] CKD patients are always associated with some comorbidities such as diabetes mellitus or hypertension, bleeding diathesis. Hence, they are always at higher operative risk compared to general population. The main drawback of PCNL in CKD is some degree of parenchymal injury in already compromised kidneys and bleeding complications especially associated to deranged blood parameters including thromobocytopenia, liver failure. Therefore, we assessed the authenticity of surgeon's hesitancy to opt for PCNL in patients with eGFR <60 ml/min/$m^2$.

The stone-free rate in our series was 67.1% after one session of PCNL, and it improved to 82% after relook PCNL (10 required relook PCNL) and improved to 94% after ancillary procedures (8 required ESWL). This is comparable with other series in the literature reporting 60%–90% clearance rates.[11-13] In our study, Group A had complete clearance after one session of PCNL was observed in 66.7% as compared to 80.9% in Group B. To the best of our knowledge, our study is one of its kind comparing the efficacy of PCNL in subgroups of CKD patients. The clearance rate was low in patients with a higher stage of CKD, which can be attributed to associated comorbidities, increased stress due to poor functioning kidneys, and bleeding causing poor visualization.

As per the literature, our research work also encountered postoperative complications. Nearly 30% (1/3$^{rd}$) cases had PCNL related complications. 9 patients in Group A required blood transfusion which may be the reason for increased cases of relook PCNL in this subset of patients. The transfusion rate in patients with CKD has been reported to be up to 10%. Our study showed a higher need for blood transfusion (20%) as more cases were performed on patients with higher CKD stage with poor blood reserve. Careful preoperative and intraoperative planning may reduce PCNL associated complications in these patients. When postoperative complications were stratified as per CD grades, more complications were encountered in patients with GFR <30. However, clinically significant complications were seen only in CD Grades 2, 3, and 4. Need of blood transfusion secondary to bleeding, ICU stay, and need of auxillary procedures for residual stones were the common complications encountered.

In a study by Kurien *et al.,*[14] 91 patients with CKD undergoing PCNL were studied for factors predicting further renal deterioration Table 4. Deterioration of the CKD stage was seen in 12 patients (13.2%). Eight patients (8.8%) required maintenance hemodialysis or renal transplantation. In our series, RRT was required in 6 patients, all belonging to Group A. Among our patients in Group A, 6 needed dialysis as compared to no one in Group B. The increased need for dialysis in patients in Group A was mainly due to electrolyte imbalance and fluid overload leading to pulmonary distress, which is common in patients with poor renal reserve.

We used a 4-variable MDRD formula to evaluate and stage kidney disease. In a study by Canes *et al*., the impact of PCNL on renal function was evaluated in 81 patients with a solitary functioning kidney. As compared to other studies that considered only serum creatinine as a marker of CKD.[10] In our study, mean eGFR pre-PCNL and peak eGFR at follow-up of 6 months were 38.52 ± 11.18 ml/min/1.73 $m^2$ and 45.55 ± 12.74 mL/min/1.73 $m^2$, respectively. In Group A GFR increased by 6.67 ± 7.7 ml/min/$m^2$ while in Group B, it increased by 8.02 ± 7.2 ml/min/$m^2$ ($P < 0.001$). The more rise in GFR in Group B could be attributed to better functional reserve, better renal function, and more functional nephrons in patients with lower CKD states. Similarly, a study by Akman *et al*. showed significant improvement in eGFR in patients with CKD after PCNL.[11] Canes *et al*. reported mean eGFR increase from 44.7 ml per minute/1.73 $m^2$ preoperatively to 55.4 ml per minute/1.73 $m^2$ by 1 year after PCNL in their study. Akman *et al*.[11] showed that renal function improved or stabilized in 90% of cases at more than a 6-month follow-up. Our study results also are consistent with this finding, and most of the cases in our series were associated with betterment in eGFR and renal function.

Increasing the use of smaller diameter sheaths and advances in laser technology should lead to increase stone clearance and decreased complications. Thus, our study can help in unleashing the blind fear that PCNL will cause long-term deterioration of renal function in patients with CKD. Although PCNL and ESWL have been documented to cause some renal injury,[5] this does not translate into any significant alteration in eGFR. We confronted some limitations of our study, which include its retrospective nature, usage of mathematical formula for eGFR calculation rather than nuclear renography, and shorter period of follow-up i.e., 6 months. Furthermore, stone-free rate was calculated using X-KUB and USG KUB rather than a CT KUB, as it would have been unethical to do so. Furthermore, there might be some bias as different surgeons operated using a different technique, i.e., mini-PCNL or standard PCNL which calls for another study to compare among themselves.

Various studies included RIRS for the management of calculus in CKD patients, but in our subset of population

due to expenses involved in RIRS as compared to PCNL, patients accepted PCNL as a method of stone clearance. Furthermore, enough CKD patients who underwent RIRS were not available for comparison. Microdust and small fragments left after RIRS, increased intrapelvic pressure created intraoperatively, and inefficient drainage after RIRS further aggravated the infection in CKD patients as compared to PCNL which was the reason for selecting PCNL over RIRS.

## CONCLUSION

PCNL is an effective management strategy for renal calculus in patients with CKD with acceptable stone clearance rates and manageable complications. CKD patients, undergoing PCNL despite high risk involved, have a better outcomes with good stone clearance rates and better renal function. Renal function was improved or at least maintained at long-term follow-up in >80% of patients with CKD who underwent PCNL. Peak eGFR <30 ml/min/$m^2$ and postprocedure complications predict deterioration and need for RRT; our findings need to be further strengthened by a prospective study of larger cohort.

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Nil.

### Conflicts of interest
There are no conflicts of interest.

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