Percutaneous nephrolithotomy in previously operated patients: A prospective study

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Abstract

**Purpose:** To determine the effect of previous renal stone surgery on result and complications of percutaneous nephrolithotomy (PCNL).

**Materials and Methods:** Total 300 patients were enrolled in the study. We enrolled 100 surgery-naive cases (those with no history of any renal surgery) as control and labeled them as Group A. Group B comprised 100 cases who had PCNL in the past. Group C constituted 100 patients who had open renal stone surgery in the past. Stones were classified using Guy’s stone score. PCNL was performed by standard technique in prone position and technical features encountered during operation and outcomes were compared between groups. Complications were graded using modified Clavien grading system.

**Results:** There were no differences between the three groups in age, gender, body mass index, stone burden, and stone opacity. Multiple calyceal stones and distorted pelvicalyceal system anatomy were more in Group C, but stone score showed no statistically significant difference from other groups. The mean operative time (68.91 ± 21.27 min) and fluoroscopy time (264.40 ± 74.90 s) were longer in Group C, but there was no statistically significant difference between the groups. Multiple access was significantly more common in Group C compared to the other two groups ($P < 0.001$). Access location too did not show any statistically significant difference between the groups. Postoperative complications were more in previous stone surgery patients, but did not show statistically significant difference.

**Conclusion:** PCNL is a safe and effective treatment modality for patients with renal stones regardless of history of previous PCNL or open renal surgery.

**Keywords:** Calculus, calyceal, percutaneous nephrolithotomy

INTRODUCTION

The lifetime prevalence of kidney stone disease is estimated at 1%–15%, varying according to age, gender, race, and geographic location.¹ The rise in the prevalence of kidney stones is a global phenomenon and its incidence and prevalence has been increasing over time around the world.² Fernstrom and Johansson (1976) first reported the technique of creating a percutaneous tract specifically to remove a stone. Subsequent reports have established percutaneous nephrolithotomy (PCNL) as the standard
technique to treat patients with large or otherwise complex calculi. As this approach is superior to open approach in terms of morbidity, convalescence, and cost, PCNL has replaced the open approach for removal of large or complex calculi at most institutions.[3,4]

Unfortunately, kidney stone disease is recurrent in nature and so it disrupts the quality of life and causes high cost to the health systems.[5] Despite appropriate surgical approach and medical prophylactic program, half of patients who have previously been treated for renal stones will face stone recurrence within 5–7 years.[6] Thus, the number of patients who need a second surgical intervention increases.[7] It is well known that previous renal stone surgery is associated with perinephric scars, distortion of pelvicalyceal anatomy, and bowel displacement that may affect results of subsequent interventions. Complications of PCNL are graded according to modified Clavein grading system.[8] The reports are conflicting regarding outcome of PCNL following open stone surgery. Some studies have reported that previous open stone surgery can increase PCNL failure rate, while others contradict it.[9,10]

Our objective was to prospectively investigate the effects of previous renal stone surgery on subsequent PCNL in terms of success and complications. Majority of previous studies are retrospective in nature, so we decided to conduct a prospective study.

MATERIALS AND METHODS

The study was performed from January 2015 to March 2017 at our institution, which is a tertiary referral center with a high load of various urological procedures. Ethical clearance was obtained from the institutional ethics committee. Three hundred patients were enrolled in the study. We enrolled 100 surgery-naive cases and labeled them as Group A. Group B comprised 100 cases who had PCNL in the past. Group C comprised 100 patients who had open renal stone surgery in the past. Patients having congenital renal abnormality such as ureteropelvic junction obstruction, congenital anomaly, body mass index (BMI) ≥30, age <18 years, and other comorbidities were excluded from the study.

Preoperative investigations comprised complete blood count, serum creatinine, bleeding and coagulation profiles, and urine culture. The radiological investigations included ultrasonography (USG), X-ray kidney–ureter–bladder (KUB), and noncontrast computed tomography (CT) KUB. Stones were classified using Guy’s stone score (GSS). PCNL was performed by standard technique in prone position. The pelvicalyceal system (PCS) was opacified by ureteric catheter. The desired calyx was punctured using an 18-gauge initial puncture needle. The tract was dilated by Alken telescopic metallic dilators over a J-tip polytetrafluoroethylene-coated guidewire up to 22 Fr. After Amplatz sheath insertion nephroscopy was performed and stones were removed and if needed stones were fragmented using pneumatic lithoclast. The procedure was completed with insertion of a 16 Fr nephrostomy tube and DJ stent as and when needed.

Patients were followed by X-ray or USG of the KUB at the time of discharge and at 4 weeks after surgery. The data recorded included age, gender, stone size (maximum diameter), stone complexity (using GSS), puncture site (supracostal or infracostal), total operative time (defined as the time from the beginning of the pyelogram to placement of nephrostomy tube), and fluoroscopy time (total time of fluoroscopy during the procedure). Postoperatively, hemoglobin and serum creatinine were done. Complications were recorded using the modified Clavien grading system and success of procedure was defined as complete clearance or presence of nonblocking clinically insignificant residual fragments (<4 mm).

Statistical analysis was performed with IBM SPSS version 20.0 (IBM Corp., Armonk, NY) using the Chi-square and ANOVA tests and P < 0.05 was considered statistically significant.

RESULTS

Table 1 shows demographic data of patients, and there was no difference between the three groups with respect to age, gender, BMI, stone burden, and stone opacity. Stones in multiple calyceal locations were more in Group C.

Table 2 shows distribution of stone as per GSS and outcome with reference to this scale. GSS Grade I was more common in all the groups; it was 47, 42, and 39 in Groups A, B, and C, respectively. Multiple calyceal stones and distorted PCS anatomy were more in Group C, but stone score did not show statistically significant difference from other groups. The mean operative time (68.91 ± 21.27 min) and fluoroscopy time (264.40 ± 74.90 s) were longest in Group C, but there was no statistically significant difference between the groups. The highest stone clearance was achieved in primary PCNL patients compared to the other groups. In our study, stone-free rate was 88% in Group 1, 87% in Group 2, and 84% in Group 3. We also evaluated success according to GSS. According to that for a GSS
of 4, success was 77.77%, 85.71%, and 71.42% for the three groups, respectively, which did not show statistically significant.

As shown in Table 3, intercostal access was in 9% of patients in Group 1, 12% in Group 2, and 15% in Group C. Multiple access was significantly more common in Group C compared to the other two groups \((P < 0.001)\). Access location was not statistically significant between the groups and middle calyx was the most frequently used tract to access the PCS in all three groups. Ten patients in Group A (10%), 12 patients in Group B (12%), and 17 patients in Group C (17%) required multiple tracts for stone removal.

Table 4 shows postoperative parameters. The mean hospitalization time and the nephrostomy time were nearly the same in all the groups. Complications were graded according to the modified Clavien classification. Postoperative complications were more in previous stone surgery patients, but the difference was not statistically significant. Postoperative fever developed in 5 (5%) patients in Group A and in 6 (6%) patients in each Group B and C, which was not statistically significant. Five patients in Group A, six in Group B, and eight in Group C received blood transfusion during or after procedures; this difference was also not statistically significant. There were only few pulmonary complications (one, one, and two in Group A, Group B, and Group C, respectively) and there was

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**Table 1: Comparison of demographic data of groups**

| Parameters                   | Group A | Group B | Group C | \(P\)  |
|------------------------------|---------|---------|---------|-------|
| \(n\)                        | 100     | 100     | 100     |       |
| Gender                       |         |         |         |       |
| Male                         | 66      | 63      | 69      | 0.6719|
| Female                       | 34      | 37      | 31      |       |
| Mean age (years)             | 38.08±9.22 | 37.87±8.84 | 38.16±8.42 | 0.9713|
| Mean BMI (kg/m\(^2\))        | 24.55±1.19 | 24.52±1.52 | 24.65±1.44 | 0.8713|
| Mean preoperative hemoglobin (g/dl) | 13.18±1.10 | 13.20±1.21 | 12.90±1.11 | 0.1201|
| Mean preoperative creatinine level (mg/dl) | 0.96±0.18 | 0.98±0.20 | 0.98±0.25 | 0.6898|
| Mean stone size (mm) (maximum diameter) | 23.57±6.63 | 24.64±8.86 | 24.00±8.53 | 0.6412|
| Degree of hydronephrosis     |         |         |         |       |
| None                         | 45      | 37      | 33      | 0.1104|
| Mild                         | 33      | 41      | 36      |       |
| Moderate                     | 16      | 16      | 19      |       |
| Severe                       | 6       | 06      | 12      |       |

BMI: Body mass index

**Table 2: Stone complexity according to Guy’s stone score**

| Parameters                  | Group A | Group B | Group C | \(P\)  |
|-----------------------------|---------|---------|---------|-------|
| GSS 1 \((n)\)               | 47      | 42      | 39      |       |
| Mean±SD total operative time (min) | 50.02±4.46 | 50.04±5.02 | 51.28±6.29 | 0.466 |
| Mean±SD fluoroscopic time (s) | 201.83±33.70 | 203.78±17.85 | 211.28±23.41 | 0.238 |
| Number of complication (%)  | 7 (14.89) | 8 (19.04) | 8 (20.51) | 0.6833|
| Number of success/total, \%(n) | 43/47 (93.61) | 39/42 (92.85) | 35/39 (89.74) | 0.5832|
| GSS 2 \((n)\)               | 25      | 24      | 26      |       |
| Mean±SD total operative time (min) | 61.95±8.05 | 62.04±8.46 | 65.80±12.79 | 0.307 |
| Mean±SD fluoroscopic time (s) | 262.30±46.15 | 265.76±31.39 | 270.34±47.62 | 0.781 |
| Number of complication (%)  | 5 (20)  | 5 (20.83) | 7 (26.92) | 0.724 |
| Number of success/total, \%(n) | 22/25 (88) | 20/24 (83.33) | 22/26 (84.61) | 0.6724|
| GSS 3 \((n)\)               | 19      | 27      | 28      |       |
| Mean±SD total operative time (min) | 84.22±10.30 | 84.38±8.40 | 86.10±15.94 | 0.834 |
| Mean±SD fluoroscopic time (s) | 285.00±43.22 | 294.64±25.16 | 308.92±61.12 | 0.195 |
| Number of complication (%)  | 4 (21.05) | 6 (22.22) | 8 (28.57) | 0.257 |
| Number of success/total, \%(n) | 16/19 (84.21) | 22/27 (81.51) | 22/28 (87.57) | 0.9679|
| GSS 4 \((n)\)               | 9       | 7       | 7       |       |
| Mean±SD total operative time (min) | 104.77±7.87 | 104.71±10.7 | 112.28±16.12 | 0.383 |
| Mean±SD fluoroscopic time (s) | 331.33±62.20 | 326.67±64.14 | 388.75±80.96 | 0.064 |
| Number of complication (%)  | 2 (22.22) | 2 (28.75) | 2 (28.75) | 0.9544|
| Number of success/total, \%(n) | 7/9 (77.77) | 6/7 (85.71) | 5/7 (71.42) | 0.6834|
| Total \((n)\)               | 100     | 100     | 100     |       |
| Mean±SD total operative time (min) | 64.01±19.58 | 65.47±18.77 | 68.91±21.27 | 0.2042|
| Mean±SD fluoroscopic time (s) | 243.60±56.52 | 253.20±61.34 | 264.40±74.90 | 0.0770|
| Number of complication (%)  | 18      | 21      | 26      | 0.4930|
| Number of success/total, \%(n) | 88/100 | 87/100 | 84/100 | 0.4606|

SD: Standard deviation, GSS: Guy’s stone score
no statistically significant difference between the groups. A total of four patients developed minimal hydrothorax, of which three were relieved with chest physiotherapy and conservative management, but one patient needed chest drain insertion. No colonic perforation was noted in any group.

**DISCUSSION**

Previous renal surgery (especially open pyelolithotomy) causes retroperitoneal fibrosis and perinephric scarring, which may lead to difficulty not only in introduction of initial puncture needle into the desired calyx but also in tract dilatation. Besides these, previous renal surgery distorts normal anatomy of PCS, which may lead to infundibular stenosis or ureteropelvic junction obstruction. Sequelae of open renal surgery such as incisional hernia and bowel displacement may lower the success rate and increase complication rates.\(^{[11,12]}\)

Previous studies described that 2–3 times more attempts were required to access the PCS in previously operated patients than in a fresh case.\(^{[12,13]}\) However, in our study, number of access attempts was not significantly different among the three groups. Puncturing the desired calyx through the nonoperated site makes the dilatation easy. Basiri* et al.* preferred a lower calyceal puncture, Kaufman and Shah recommended a supracostal approach, to avoid scar tissue, whereas Margel *et al.* in their study suggested upper-pole calyceal puncture.\(^{[9,12,14]}\) However, in our study, we selected the puncture site and calyx depending on the stone location regardless of its relation to scar tissue without lowering success and increase in complication rates.

Retropertitoneal and perinephric scarring make the dilation of the tract difficult. Sharp incision of fascia with surgical blade may be used to facilitate dilatation.\(^{[14]}\) Dilation with metal dilator is associated with high risk of renal perforation and so balloon dilation is recommended, but in our department, metal dilators are being used successfully and incidence of pelvic perforation is negligible.\(^{[13]}\) This may be due to the large bulk of renal calculus being operated here with this dilatation technique.

The mean operative time in our study was greater in Group C, but this was not statistically significant. We also recorded the mean operative time in context of the GSS within the groups. GSS of 4 in previous open operated patients have the highest operative time, but this was also not statistically significant. Some studies have, however, reported that mean operative time was significantly longer in patients with previous open surgery.\(^{[16,17]}\) Increased operative time in previously operated patients may be due to multiple attempts to puncture, difficult tract dilatation in scarred kidney and fixity of kidney to the retroperitoneum making access of pelvicalyceal system difficult by rigid nephroscope.\(^{[17]}\)

In our study, the fluoroscopy time was longest in Group C, but it was not statistically significant. In Group C, stone distribution was complex and stones were found to be occupying different calyces, which was associated with increased number of access attempts which also increased fluoroscopy time. Similar to our study, greater number of access attempts was reported by Ozgor *et al.* who also reported more fluoroscopy time in previously operated cases.\(^{[18]}\)

**Table 3: Operative parameters**

| Parameters                  | Group A | Group B | Group C | P       |
|-----------------------------|---------|---------|---------|---------|
| n                           | 100     | 100     | 100     |         |
| Intercostal access          | 09      | 12      | 15      | 0.4291  |
| Mean access number          | 1.17±0.37 | 1.19±0.39 | 1.32±0.54 | 0.0373  |
| Access location             |         |         |         |         |
| Multiple                    | 10      | 12      | 17      | 0.3932  |
| Upper calyx                 | 25      | 23      | 25      |         |
| Middle calyx                | 43      | 41      | 37      |         |
| Lower calyx                 | 22      | 24      | 21      |         |
| Short tract                 | 1       | 2       | 4       | 0.361   |
| Pelvic perforation          | 1       | 1       | 4       | 0.218   |

**Table 4: Postoperative parameters**

| Parameters                          | Group 1 | Group 2 | Group 3 | P       |
|-------------------------------------|---------|---------|---------|---------|
| Mean nephrostomy duration (days)    | 2.28±0.35 | 2.32±0.39 | 2.39±0.44 | 0.1216  |
| Mean hospitalization time (days)    | 3.1±0.59  | 3.09±0.54 | 3.22±0.70 | 0.2590  |
| Mean hemoglobin drop (g/dl)         | 1.14±0.28 | 1.13±0.35 | 1.22±0.32 | 0.1662  |
| Postoperative complications         |         |         |         |         |
| Clavien Grade 1                     |         |         |         |         |
| Fever (with no change of antibiotics)| 5       | 6       | 6       | 0.9401  |
| Transient increase in creatinine    | 2       | 2       | 2       | 1.000   |
| Clavien Grade 2                     |         |         |         |         |
| Nephrostomy site leakage for 12 h   | 3       | 3       | 4       | 0.9026  |
| Blood transfusion                   | 5       | 7       | 8       | 0.6896  |
| Infection requiring additional antibiotics | 2 | 2 | 3 | 0.8651 |
| Clavien Grade 3a                    |         |         |         |         |
| Hydrothorax                         | 1       | 1       | 2       | 0.7780  |
There are conflicting reports regarding post-PCNL hospitalization period. Some studies reported increase in hospitalization time in patients having previous open surgery, whereas other studies contradicted it.\[16,17,19,20\] In our study, hospitalization time was more in Group C patients, but this was not statistically significant.

Our study shows that there is no statistically significant difference between the groups in terms of stone free rates. The rate of auxiliary procedures such as re-look PCNL was the same in all groups. Gupta et al. showed that relook PCNL was higher in patients with previous open surgery, whereas other studies reported that rates of auxiliary procedures were similar among the groups.\[10,17,19,21\] We did not find any statistically significant difference in complication rate as was reported by Onal et al. and Ozgor et al., whereas some previous studies contradict it.\[10,18,21‑23\]

Hemorrhage is the most significant complication of PCNL with transfusion rates reported to be from <1% to up to 10%\[10,18\]. Excessive bleeding can occur during tract dilatation in previously operated cases as retroperitoneal and calyceal scarring may fix the kidney necessitating excessive manipulation during nephroscopy and may result in injury to kidney with acute bleeding.\[10,20\] None of the patients needed angioembolization in our study. Blood transfusion rate was 8% in Group C patients, which was not statistically significant between Group A (5%) and Group B (6%).

The risk of pleural injury during supracostal access for PCNL has been reported to be between 0% and 12.5%.\[10,17\] We did not find any statistically significant difference statistically with respect to pleural injury among the groups. Resorlu et al. and Ozgor et al. also supported the same.\[18,24\] Colon perforation is an unusual but serious complication of PCNL, especially in patients with history of open renal surgery.\[19,25\] In order to prevent that undesirable situation, Gedik et al. suggested routine CT scan in all patients with a history of open renal surgery.\[29\] Another way to decrease this risk with no radiation exposure is puncture under USG guidance.\[19\] In our study, we did not encounter any case of colonic perforation.

Overall, the stone-free rate was 88% in Group A, 87% in Group B, and 84% in Group C, which was not statistically significant. On evaluating the success rate according to GSS, Grade 4 group had 77.77%, 85.71%, and 71.42% success rate in the three groups, respectively. Sofikerim et al. found no difference in success rates in groups with or without open renal surgery in past.\[18\] Lojanapiwat's study reported result with 80.3% and 82.6% stone-free rate in patients with and without previous open renal surgery, respectively.\[11\] Whereas conflicting to these, Viville and Jones et al. found higher failure rate in patients with a history of open renal surgery.\[25,27\]

To the best of our knowledge, ours is the only prospective study with fairly good number of patients comparing fresh cases with those who have had previous history of either PCNL or open renal surgery. Our study is not without limitation. One of them being a single-center study. Moreover, we used USG and KUB X-ray to assess the stone-free rates which is inferior to the gold-standard nonenhanced CT scan.

CONCLUSION

PCNL is both effective and safe treatment modality for patients with renal calculus regardless of history of previous PCNL or open renal surgery, and the benefits of this minimally invasive technique can be extended to all; however, further large prospective multicentric studies can be done.

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Conflicts of interest

There are no conflicts of interest.

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