

# 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 ( $68.91 \pm 21.27$  min) and fluoroscopy time ( $264.40 \pm 74.90$  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

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**Received:** 31.12.2019, **Accepted:** 18.07.2020, **Published:** 04.11.2020.

## INTRODUCTION

The lifetime prevalence of kidney stone disease is estimated at 1%–15%, varying according to age, gender, race, and geographic location.<sup>[1]</sup> 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.<sup>[2]</sup> 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

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Quick Response Code:	Website: <a href="http://www.urologyannals.com">www.urologyannals.com</a>
	DOI: 10.4103/UA.UA_175_19

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**How to cite this article:** Gulani A, Kumar U, Yadav SS, Vohra RR, Singh VK. Percutaneous nephrolithotomy in previously operated patients: A prospective study. *Urol Ann* 2021;13:24-9.

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.<sup>[3,4]</sup>

Unfortunately, kidney stone disease is recurrent in nature and so it disrupts the quality of life and causes high cost to the health systems.<sup>[5]</sup> 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.<sup>[6]</sup> Thus, the number of patients who need a second surgical intervention increases.<sup>[7]</sup> 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 Clavien grading system.<sup>[8]</sup> 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.<sup>[9,10]</sup>

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 ureteropelvic junction obstruction, congenital anomaly, body mass index (BMI)  $\geq 30$ , 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 1 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 ( $68.91 \pm 21.27$  min) and fluoroscopy time ( $264.40 \pm 74.90$  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

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

Parameters	Group A	Group B	Group C	P
<i>n</i>	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 <sup>2</sup> )	24.55±1.19	24.62±1.52	24.65±1.44	0.8713
Mean preoperative hemoglobin (g/dl)	13.18±1.20	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 ( <i>n</i> )	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, <i>n</i> (%)	43/47 (93.61)	39/42 (92.85)	35/39 (89.74)	0.5832
GSS 2 ( <i>n</i> )	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, <i>n</i> (%)	22/25 (88)	20/24 (83.33)	22/26 (84.61)	0.6724
GSS 3 ( <i>n</i> )	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, <i>n</i> (%)	16/19 (84.21)	22/27 (81.15)	22/28 (78.57)	0.9679
GSS 4 ( <i>n</i> )	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, <i>n</i> (%)	7/9 (77.77)	6/7 (85.71)	5/7 (71.42)	0.6834
Total	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	25	0.4930
Number of success/total, <i>n</i> (%)	88/100	87/100	84/100	0.4606

SD: Standard deviation, GSS: Guy's stone score

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

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.<sup>[11,12]</sup>

Previous studies described that 2–3 times more attempts were required to access the PCS in previously operated patients than in a fresh case.<sup>[12,13]</sup> 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.<sup>[9,12,14]</sup> 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.

Retroperitoneal and perinephric scarring make the dilation of the tract difficult. Sharp incision of fascia with surgical blade may be used to facilitate dilatation.<sup>[14]</sup> Dilatation with metal dilator is associated with high risk of renal perforation and so balloon dilatation is recommended, but in our department, metal dilators are being used successfully and incidence of pelvic perforation is negligible.<sup>[15]</sup> 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.<sup>[16,17]</sup> 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.<sup>[17]</sup>

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.<sup>[18]</sup>

**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.<sup>[16,17,19,20]</sup> 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.<sup>[10,17,19,21]</sup> 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.<sup>[10,18,21-23]</sup>

Hemorrhage is the most significant complication of PCNL with transfusion rates reported to be from <1% to up to 10%.<sup>[10,18]</sup> 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.<sup>[10,20]</sup> 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%. 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.<sup>[18,24]</sup> Colon perforation is an unusual but serious complication of PCNL, especially in patients with history of open renal surgery.<sup>[19,25]</sup> In order to prevent that undesirable situation, Gedik *et al.* suggested routine CT scan in all patients with a history of open renal surgery.<sup>[26]</sup> Another way to decrease this risk with no radiation exposure is puncture under USG guidance.<sup>[19]</sup> 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.<sup>[10]</sup> Lojanapiwat's study reported result with 80.3% and 82.6% stone-free rate in

patients with and without previous open renal surgery, respectively.<sup>[11]</sup> Whereas conflicting to these, Viville and Jones *et al.* found higher failure rate in patients with a history of open renal surgery.<sup>[25,27]</sup>

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.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Stamatelou KK, Francis ME, Jones CA, Nyberg LM, Curhan GC. Time trends in reported prevalence of kidney stones in the United States: 1976-1994. *Kidney Int* 2003;63:1817-23.
2. Romero V, Akpınar H, Assimos DG. Kidney stones: A global picture of prevalence, incidence, and associated risk factors. *Rev Urol* 2010;12:e86-96.
3. Segura JW, Patterson DE, LeRoy AJ, McGough PF, Barrett DM. Percutaneous removal of kidney stones. Preliminary report. *Mayo Clin Proc* 1982;57:615-9.
4. Matlaga BR, Assimos DG. Changing indications of open stone surgery. *Urology* 2002;59:490-3.
5. Hyams ES, Matlaga BR. Cost-effectiveness treatment strategies for stone disease for the practicing urologist. *Urol Clin North Am* 2013;40:129-33.
6. Parmar MS. Kidney stones. *BMJ* 2004;328:1420-4.
7. Antonelli JA, Maalouf NM, Pearle MS, Lotan Y. Use of the National Health and Nutrition Examination Survey to calculate the impact of obesity and diabetes on cost and prevalence of urolithiasis in 2030. *Eur Urol* 2014;66:724-9.
8. Thomas K, Smith NC. The Guy's Stone Score – Grading the complexity of percutaneous nephrolithotomy procedures. *Urology* 2011;78:277-81.
9. Basiri A, Karrami H, Moghaddam SM, Shadpour P. Percutaneous nephrolithotomy in patients with or without a history of open nephrolithotomy. *J Endourol* 2003;17:213-6.
10. Sofikerim M, Demirci D, Gülmez I, Karacagil M. Does previous open nephrolithotomy affect the outcome of percutaneous nephrolithotomy? *J Endourol* 2007;21:401-3.

11. Lojanapiwat B. Does previous open nephrolithotomy affect the efficacy and safety of tubeless percutaneous nephrolithotomy? *Urol Int* 2010;85:42-6.
12. Margel D, Lifshitz DA, Kugel V, Dorfmann D, Lask D, Livne PM. Percutaneous nephrolithotomy in patients who previously underwent open nephrolithotomy. *J Endourol* 2005;19:1161-4.
13. Gupta R, Gupta A, Singh G, Suri A, Mohan SK, Gupta CL. PCNL—a comparative study in nonoperated and in previously operated (open nephrolithotomy/pyelolithotomy) patients – A single-surgeon experience. *Int Braz J Urol* 2011;37:739-44.
14. Kaufman JD, Shah O. Balloon dilation for establishing percutaneous renal access in complex cases: Incidence of and risks for failure. *J Endourol* 2006;20:A19.
15. Lynch W, Doust B, Golovsky D. Percutaneous dilatation of difficult nephrostomy tracts. *Br J Urol* 1992;70:455-6.
16. Tugcu V, Su FE, Kalfazade N, Sahin S, Ozbay B, Tasci AI. Percutaneous nephrolithotomy (PCNL) in patients with previous open stone surgery. *Int Urol Nephrol* 2008;40:881-4.
17. Khorrani M, Hadi M, Sichani MM, Nourimahdavi K, Yazdani M, Alizadeh F, *et al.* Percutaneous nephrolithotomy success rate and complications in patients with previous open stone surgery. *Urol J* 2014;11:1557-62.
18. Ozgor F, Kucuktopcu O, Sarilar O, Toptas M, Simsek A, Gurbuz ZG, *et al.* Does previous open renal surgery or percutaneous nephrolithotomy affect the outcomes and complications of percutaneous nephrolithotomy. *Urolithiasis* 2015;43:541-7.
19. Kurtulus FO, Fazlioglu A, Tandogdu Z, Aydin M, Karaca S, Cek M. Percutaneous nephrolithotomy: Primary patients versus patients with history of open renal surgery. *J Endourol* 2008;22:2671-5.
20. Yesil S, Ozturk U, Goktug HN, Tuygun C, Nalbant I, Imamoglu MA. Previous open renal surgery increased vascular complications in percutaneous nephrolithotomy (PCNL) compared with primary and secondary PCNL and extracorporeal shock wave lithotripsy patients: A retrospective study. *Urol Int* 2013;91:331-4.
21. Gupta NP, Mishra S, Nayyar R, Seth A, Anand A. Comparative analysis of percutaneous nephrolithotomy in patients with and without a history of open stone surgery: Single center experience. *J Endourol* 2009;23:913-6.
22. Onal B, Gevher F, Argun B, Dogan C, Citgez S, Onder AU, *et al.* Does previous open nephrolithotomy affect the outcomes and complications of percutaneous nephrolithotomy in children? *J Pediatr Urol* 2007;10:730-6.
23. Falahatkar S, Panahandeh Z, Ashoori E, Akbarpour M, Khaki N. What is the difference between percutaneous nephrolithotomy in patients with and without previous open renal surgery? *J Endourol* 2009;23:1107-10.
24. Resorlu B, Kara C, Senocak C, Cicekbilek I, Unsal A. Effect of previous open renal surgery and failed extracorporeal shockwave lithotripsy on the performance and outcomes of percutaneous nephrolithotomy. *J Endourol* 2010;24:13-6.
25. Viville C. Percutaneous nephrolithotomy: Personal experience in 100 cases. *J Urol* 1987;93:253-8.
26. Gedik A, Tutus A, Kayan D. Percutaneous nephrolithotomy in pediatric patients: Is computerized tomography a must? *Urol Res* 2011;39:45-9.
27. Jones DJ, Russell GL, Kellett MJ, Wickham JE. The changing practice of percutaneous stone surgery. Review of 1000 cases 1981-1988. *Br J Urol* 1990;66:1-5.