Can We Reduce Secondary Surgical Interventions and Length of Hospitalization in Percutaneous Nephrolithotomy?

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Purpose: To evaluate the success and complication rates of percutaneous nephrolithotomy (PNL) operations and to determine the effect of postoperative late removal of an open-end ureter catheter on hospital stay and on secondary interventions.

Materials and Methods: The records of 198 patients (97 female, 101 male) who had PNL between May 2009 and February 2012 were retrospectively reviewed. The open-end ureter catheter which was placed during the operation was removed at the end of the operation in the first 53 patients (group 1) and 12 hours after the nephrostomy catheter in 145 patients (group 2).

Results: PNL intervention was performed in 198 patients with a mean age of 40.83 ± 13.64 years and mean stone load of 9.82 ± 5.37cm^2 (range 2 to 26 cm^2). When clinically insignificant stone pieces < 4 mm were accepted as successful, the total success rate was 80.80 % (79.2% in group1 and 81.4% in group 2, $P = .50$). The hospitalization period was significantly reduced in group 2 (3.45 ± 0.95 days vs. 2.61 ± 0.65 days; $P = .006$). While secondary surgical intervention was not necessary in any of the patients in group 2 (0.0%), but 4 patients (7.5%) required ureterorenoscopy plus double-J stent placement following the primary procedure in group 1 ($P = .006$).

Conclusion: PNL is a safe procedure with a high success rate and a short hospitalization period. There was a significant decrease in the hospitalization period and secondary surgical intervention rates with the postoperative late removal of the open-end ureter catheter.

Keywords: kidney calculi; surgery; nephrostomy; percutaneous; methods; treatment outcome; nephrolithiasis; retrospective studies.

INTRODUCTION

The contemporary treatment of stone disease, which is a serious health problem, has made great progress in recent years. In particular, because of the improvements in extracorporeal shock wave lithotripsy (SWL), ureterorenoscopy (URS), intracorporeal lithotripsy and percutaneous surgery, only 0.7-4% of urinary system stones now need open surgery.[1,2]

Percutaneous nephrolithotomy (PNL), which is a minimal invasive surgical method, was first introduced in 1976 by Fernström and Johansson.[3] PNL is a method, the effectiveness and reliability of which has been proven in the treatment of kidney stones, thanks to developments in surgical instruments and technology along with an increase in surgical experience.[4] PNL is becoming a more preferred treatment method in stone surgery for reasons such as low morbidity and a short hospitalization period.[5] PNL has mostly replaced open surgery and in many centers PNL is recommended as the first choice in the treatment of kidney stones larger than 2 cm.[6,7]

In this study, we aimed to evaluate the success and complication rates of percutaneous nephrolithotomy operations and to determine the effect on hospital stay and the rate of secondary interventions of the postoperative late removal of open-end ureter catheter which was placed during PNL operations for the visualization of the collecting system.

MATERIALS AND METHODS

PNL intervention was performed in 198 patients (97 female, 101 male) with a mean age of 40.83 ± 13.64 years (range, 9 to 76 years). The open-end ureter catheter placed during the operation was removed at the end of the operation in the first 53 patients (group 1) and 12 hours after the nephrostomy catheter in 145 patients (group 2). The patients were evaluated routinely with full urine analysis, serum biochemistry, bleeding and coagulation time, direct urinary system graph (DUS) and ultrasonography (USG). The patients with normal serum creatinine levels were evaluated with intravenous urography (IVU) and the patients with high serum creatinine levels were evaluated with non-contrast abdominal computerized tomography (CT) scan. The size of the stones was calculated by measuring the longest diameter and the diameter perpendicular to this and multiplying the values for a cm^2 result. All patients with a sterile pre-operation urine culture were administered third generation cephalosporin as prophylaxis one hour before the operation and on the first day post-operatively, oral antibiotics were administered. Patients with growth in the urine culture were discharged with a suitable treatment plan and when the urine culture was sterile, they were readmitted for the operation.

PNL Procedure

Following general anesthesia, a 6 French (F) open-end ureter catheter was placed in the lithotomy position. After fitting the ureter catheter, an appropriate calyx was entered with an 18 gauge percutaneous entrance needle (Boston Scientific, Natick, MA, USA). Amplatz mechanical dilatators were used for percutaneous tract dilatation (Amplatz sheath, Boston Scientific, Natick, MA, USA). A pneumatic lithotripter was used for in vivo lithotripsy in all cases. At the end of the operation, a 14 F nephrostomy tube was placed in the patients, except for those patients with significant bleeding to whom a 22 F Pezzer drain nephrostomy was applied. The open-end ureter catheter that was placed during the operation to visualize the collecting system was removed either at the end of the operation or 12 hours after the nephrostomy catheter was removed. The nephrostomy tube of patients without hematuria was removed postoperatively on the first or second day.

At the 1 and 3-month follow-up examinations, USG was performed. When USG imaging was insufficient, non-contrast abdominal CT was performed in 23 patients (6 patients in group 1 and 17 patients in group 2). The presence of a stone ≥ 4 mm was accepted as residue and PNL and/or SWL was carried out at least one month later.

Statistical Analysis

Statistical analyses were performed using statistical package for the social science (SPSS Inc, Chicago, Illinois, USA) version 20.0. Results were expressed as mean ± standard deviation (SD). The differences between the two groups for continuous variables (age, operation time, stone load, nephrostomy removal time and hospitalization time) were analyzed by independent samples *t* Test and for categorical data (stone location, prolonged drainage, secondary surgical intervention, success rate and complication rates) by Fisher's exact test. A *P* value of ≤ .05 was considered statistically significant.

Table 1. The preoperative characteristics of both groups.

Variables	Group 1	Group 2	*P*
Age (years), (mean ± SD)	38.69 ± 15.33	41.61 ± 12.93	.28
Stone load (cm^2), (mean ± SD)	9.78 ± 6.69	9.83 ± 4.82	.09
Stone location, no. (%)			
Pelvis	7 (13.2)	48 (33.1)	.02
Lower calyx	12 (22.6)	46 (31.7)	.22
Upper calyx	2 (3.8)	8 (5.5)	.48
Pelvis and calyx	13 (24.5)	28 (19.3)	.32
Calyx diverticulum	3 (5.7)	4 (2.8)	.29
Proximal ureter	8 (15.1)	1 (7.0)	.00
Staghorn	8 (15.1)	10 (6.7)	.096

RESULTS

In total, the mean stone load was 9.82 ± 5.37 cm^2 (range 2 to 26 cm^2). Stone localization was determined as only in the pelvis in 55 (27.8%) patients, only in the lower calyx in 58 (29.3%), only in the upper calyx in 10 (5.1%), in both pelvis and calyx in 41 (20.7%), in the calyx diverticulum in 7 (3.5%), in the proximal ureter in 9 (4.5%) and 18 (9.1%) patients had staghorn stones. The pre-operative characteristics of patients in group1 and group 2 are given in Table 1. The mean operation time was 75.40 ± 16.05 min. While 183 patients were entered subcostally, in 15 patients supracostal entrance was preferred.

When clinically insignificant stone pieces with the largest diameter of < 4 mm were accepted as successful, the total success rate was 80.8% (160/198). Similar success rates were obtained in both groups (79.2% in group 1 vs. 81.4% in group 2; $P = .50$). One month following PNL, 38 (19.2%) patients were PNL and/or SWL for residual stones. The PNL and/or SWL rate was similar between the groups ($P = .46$). At the 3-month follow-up none of the patients had any stone residue.

Table 2 summarizes the operative features and post-operative results related to the PNL procedure in total and in both groups. Prolonged drainage (> 24 hours) from the nephrostomy tract was observed in two patients in group 2. The drainage of the patients ceased after 36 hours without any intervention. No patient in this group needed a secondary surgical intervention. In group 1, on the other hand, prolonged drainage was observed in 5 patients ($P = .018$). While 1 patient did not need any extra intervention, the other 4 patients had URS under spinal anesthesia. In 2 of the URS patients a 3-4 mm stone was found in the distal ureter and removed by forceps. No pathology other than ureteral edema was encountered in the remaining 2 patients. A double-J stent was placed in 4 patients who had URS during the operation.

While secondary surgical intervention was not necessary in any of the patients in group 2 (0.0%), 4 patients (7.5%) required URS plus double-J stent placement following the primary procedure in group 1 ($P = .006$).

The hospitalization period was significantly reduced in group 2. The mean hospital stay was found to be 3.45 ± 0.95 days in group 1 and 2.61 ± 0.65 days in group 2 ($P = .006$). On postoperative day 25, one patient with a massive hemorrhage was referred to an advanced center. An A-V fistula was detected on the renal angiography of the patient and the hemorrhage ceased after the embolization of the A-V fistula. In one case with a proximal ureter stone, the ureter was perforated when the stone was being removed by forceps. This patient was fitted with an anterograde double-J stent and the double-J stent was removed in the postoperative third week.

Table 2. The per-operative characteristics and post-operative results of the percutaneous nephrolithotomy procedure in all patients and in both groups.

Variables	All Patients (n = 198)	Group 1 (n = 53)	Group 2 (n =145)	P*
Operation time (min), (mean ± SD)	75.40 ± 16.05	69.90 ± 17.96	77.41 ± 14.86	.45
Nephrostomy removal (days), (mean ± SD)	1.24 ± 0.45	1.26 ± 0.48	1.22 ± 0.43	.16
Prolonged drainage from nephrostomy, no. (%)	7 (3.5)	5 (9.4)	2 (1.4)	.018
Secondary surgical intervention, no. (%)	4 (2)	4 (7.5)	0 (0.0)	.006
Success rate, no. (%)	160 (80.8)	42 (79.2)	118 (81.4)	.50
Hospital stay (days), (mean ± SD)	2.83 ± 0.83	3.45 ± 0.95	2.61 ± 0.65	.006
Reoperation, no. (%)	38 (19.2)	11 (20.8)	27 (18.6)	.46
PNL/SWL, no.	24/14	8/3	16/11	

Keys: PNL, percutaneous nephrolithotomy; SWL, extracorporeal shockwave lithotripsy,
* Comparison between group 1 and group 2.

None of the patients had any abdominal organ damage or hydro-pneumothorax following the procedure. The complication rates are summarized according to the modified Clavien system in Table 3.

DISCUSSION

PNL was first introduced as a minimally invasive surgical method by Fernström and Johansson for the first time in 1976.[3] Today, PNL is a method, the effectiveness and reliability of which has been proven in the treatment of kidney stones. PNL is replacing open surgery and is generally recommended as the first choice in the treatment of kidney stones larger than 2 cm.[6,7] PNL has applications as the first choice in complex kidney stones which have resulted in a dilated pelvicalyceal system due to obstruction, and also in kidney stones of large sizes and chemical structures that are not suitable for SWL or stones that are located in the lower calyx, isolated calyx, diverticulum and those that are staghorn.[4] In PNL studies, the success rate of PNL surgery ranges from 72% to 98% in wide series.[8-10] Factors such as differences in stone volume, dilatation in the collecting system, the presence of complex structures within the collecting system and the experience of the surgeon are all held responsible for the wide variation in the success rates.[11] The success rate in the current study, when the residual pieces with no clinical meaning are accepted as successful, was found to be 81% which conforms to literature.

Prolonged drainage from the nephrostomy tract is a commonly seen situation in PNL treatment. This situation lengthens the hospitalization period and increases the secondary intervention rates. In the study carried out by Agrawal and colleagues, this rate was found to be 6.9%.[12] In the current series 3.5% of all patients had prolonged drainage from the nephrostomy tract. In group 1 patients this rate was 9.4% (5/53), while in group 2 only 1.4% (2/145) of cases showed prolonged drainage.

Prolonged drainage from the nephrostomy tract after removal of the nephrostomy tube, which necessitates a double-J stent placement, is considered to be a grade 3 complication according to the modified Clavien system.[13] In the current study, double-J stent placement due to prolonged drainage was not required in any of the patients in group 2 but 4 patients in group 1 required double-J stent placement due to prolonged drainage. This procedure can be considered to minimize grade 3 complications in the modified Clavien system.

Lee and colleagues reported 1.5% of patients in whom urine leakage persisted for more than 1 week from the percutaneous tract without a double-J stent placement.[9] In a study by Binbay and colleagues, 4.3% of patients underwent double-J stent placement because of urine leakage persisting for more than 24 hours after removal of the nephrostomy tube.[14] In the current study, 4 (7.5%) patients from group 1 received double-J stent, while none from group 2 required this pro-

Table 3. The complication rates of percutaneous nephrolithotomy in both groups according to the modified Clavien system.

Modified Clavien Grading System	Group 1 (n = 53)	Group 2 (n = 145)	*P*
Grade 1: Hemorrhage not requiring transfusion (n = 32), postoperative high fever > 38 °C (n = 16)), [no (%)]	12 (22.7)	36 (24.9)	.6
Grade 2: Hemorrhage requiring transfusion (n = 8), [no (%)]	4 (7.6)	4(2.8)	.14
Grade 3a: Ureter perforation (n = 1), hydropneumothorax (n = 0), double J stent placement for urine leakage > 24h (n = 4), no. (%)	5 (9.4)	0	.001
Grade 3b: Arteriovenous fistula, no. (%)	0.0	1(0.6)	0.7
Grade 4a: no. (%)	0.0	0.0	---
Grade 4b: no. (%)	0.0	0.0	---
Grade 5: no. (%)	0.0	0.0	---
PNL/SWL, no.	24/14	8/3	---

Keys: PNL, percutaneous nephrolithotomy; SWL, extracorporeal shockwave lithotripsy.
* Comparison between group 1 and group 2.

cedure.

The total stone burden has also been reported to affect the hospitalization period after PNL.[15] Although the mean stone size was higher in group 2 in the current study, the hospital stay of those patients was significantly shorter.

Limb and Bellman reported that the period of hospitalization was significantly shorter in patients undergoing tubeless PNL.[16] One of the most important disadvantages of the tubeless technique using a double-J stent for internal drainage is the need for postoperative cystoscopy to remove the stent. In the current study, when the method described here was used, there was no need either for cystoscopy or for secondary surgical interventions such as double-J stent removal.

The late removal of the open-end ureter catheter not only provides urine drainage but also secures the resolution of post-operative edema in the ureter while at the same time helps dilatation of the ureter. As a result of this drainage and ureter dilatation the nephrostomy tract of those patients closes up early. In addition, the remaining stone pieces and the coagulations formed during the operation are easier to extract through the open-end ureter catheter. These seem to be the main reasons behind the shortened hospitalization period and the lesser need for secondary intervention with the late removal of the open-end ureter catheter.

After frequent observation of prolonged drainage and secondary intervention rates from the nephrostomy tract following removal of the nephrostomy tube in the first 53 patients (group 1), we considered that late removal of the open-end ureter catheter could minimize the previously mentioned complications and we began our application. In patients, the late removed open-end ureter catheter not observed any obstructions in catheter lumen by clots and stone debris. We suggest that as in double-J stent obstructions, even open-end ureter catheter lumen is obstructed, passage can be maintained around the catheter. To the best of our knowledge, there are no similar studies in literature evaluating the hospitalization period and secondary interventions after PNL. Although this is a first report, the results of our study showed the advantages of late removal of the open-end ureter catheter such as shortening the hospitalization period after PNL and a reduced need for secondary interventions such as ureterorenoscopy and double-J stent placement. Therefore, it is our opinion that because of the above-mentioned advantages, this approach may be extensively used in clinics where PNL is widely applied. The limitations of this study are the small number of patients and the retrospective chart review. However, further prospective, randomized and controlled studies are needed to prove the assertion of the present study.

CONCLUSION

PNL can be carried out safely by trained urologists with a short hospitalization period, high stoneless rates and acceptable side effects. In this study, we showed that the hospitalization period and requirement for secondary surgical interventions decreased with the postoperative late removal of open-end ureter catheter.

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CONFLICT OF INTEREST

None declared.

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