Predictors of salvage percutaneous nephrolithotomy: experience in 752 patients

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Objectives
To determine the predictors of salvage percutaneous nephrolithotomy (PNL).
Patients and methods
From March 2012 to July 2019, the medical records of 752 patients who underwent primary PNL were reviewed retrospectively; of whom 78 patients underwent second-look PNL. Patient demographic, stone characteristics, and the reasons for the failure of the previous PNL are studied.
Results
Seventy-eight patients out of 752 at our center underwent a second-look PNL. Indications for second-look PNL were residual stones in 54 (69.2%) patients, unsuitable access in nine (11.5%), bleeding (Clavien I/II – with or without transfusion) in eight (10.3%), pelvicalyceal perforation in four (5.1%) and turbid urine in three (3.8%).
Conclusion
Salvage PNL remains an important tool for treating residual renal calculi. Harder, significant residual stones and intraoperative complications necessitating rapid termination of the primary procedure might be the predictors for the need to salvage PNL.

Keywords:
Endoscopy, kidney calculi, urolithiasis

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Introduction

Percutaneous nephrolithotomy (PNL) is considered the first line of treatment for large and complex upper urinary tract stones [1,2]. Sometimes, this procedure could be challenging and carries a risk of significant morbidity. The complications after PNL can be as high as 25%, nearly 5% of which are Clavien grade III or higher [3].

An important step during PNL is to obtain proper intrarenal access. The inability to perform this critical step can lead to morbidity and treatment failure. Prior studies estimate that a minimum of 60 cases is required to achieve competence in obtaining access and 115 procedures to achieve excellence [4,5].

Treatment failure in PNL may be underreported in the published literature [6,7]. In the meantime, treatment failures after other minimally invasive procedures such as shock wave lithotripsy (SWL) and ureteroscopy are well characterized [8,9].

The literature evaluating the indications and outcomes of second-look PNL is scarce [7]. To the best of our knowledge, prior studies analyzing outcomes of PNL performed in the salvage setting are limited to PNL post-SWL failure only and no study has assessed the outcomes of salvage PNL postinitial PNL failure [7]. Herein, the principal goal is to evaluate the indications of second-look PNL in our center.

Patients and methods

From March 2012 to July 2019, the medical records of 752 patients who underwent primary PNL were reviewed retrospectively; of whom 78 (10.3%) patients underwent second-look PNL. This was performed 1 week after the primary procedure during the same admission. Our study was approved by our institutional ethical committee under no. 300185. Written informed consent was obtained from all patients.

Patients were evaluated for laboratory investigations as blood urea and serum creatinine, urine analysis, urine culture and sensitivity tests, hemoglobin level, coagulation profile, and blood sugar level were

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performed for all patients. Imaging studies including kidney, ureter, bladder radiograph, and nonenhanced multislice computed tomography (MSCT) were done. The stone hardness was measured by MSCT.

Patient demographic, stone characteristics and the reasons for the failure of the primary PNL are shown in Table 1. If the patient has a percutaneous nephrostomy tube, a guide wire was inserted through it, and the technique was done. When another track targeting the residual stones were needed, a new puncture and tract balloon dilation were accomplished.

Operative data including the number of access tracts, operative time, placement of a nephrostomy tube, the ureteric catheter or JJ stent, drop in hemoglobin level, hospital stay, stone-free status, complications and need for a secondary procedure [SWL, retrograde intrarenal surgery (RIRS)] were recorded (Table 2). Complications were graded according to the modified Clavien-Dindo classification of surgical complications.

Data were collected, revised, coded, and entered into the Statistical Package for Social Science (IBM SPSS Inc., Chicago, IL, USA), version 20. The qualitative data were presented as numbers and percentages while quantitative data were presented as mean, SD, and ranges when their distribution was found parametric. The comparison between two groups with qualitative data was done by using the χ^2 test and/or Fisher exact test was used instead of the χ^2 test when the expected count in any cell was found less than 5. The comparison between two independent groups with quantitative data and parametric distribution was done by using paired t test. The confidence interval was set to 95% and the margin of error accepted was set to 5%. The P value less than 0.05 is considered significant and P value less than 0.001 is highly significant.

Results

A total of 752 patients underwent unilateral primary PNL at our center during the study period. Second-look PNL was indicated in 78 (10.3%) patients. The mean age of the patients was 51.3±9.2 years. Patients' demographics and stone characteristics are shown in Table 1.

Indications for second-look PNL were residual stones in 54 (69.2%) patients, unsuitable access in nine (11.5%), bleeding (Clavien I/II – with or without transfusion) in eight (10.3%), pelvicalyceal perforation in four (5.1%) and turbid urine in three (3.8%). The number of access tracts was single in 64 (82.1%) patients and multiple in 14 (17.9%). The mean operative time was 123±47.7 min, while the mean hospital stays were 3.5±1.1 days.

Table 1 Preoperative patient demographics, stone characteristics, and reasons for primary percutaneous nephrolithotomy failure

Variables	Mean±SD/*n* (%)
Sex	
Male	52 (66.70)
Female	26 (33.3)
Age	51.3±9.2
BMI (kg/m^2)	29.4±2.3
Maximum stone diameter (cm)	3.7±1.1
Location of stone	
Calyceal	30 (38.5)
Pyelocaliceal	26 (33.3)
Pelvic	22 (28.2)
Several stones	
Single	57 (73.07)
Multiple	21 (26.9)
Opacity	
Radiopaque	61 (78.2)
Radiolucent	17 (21.8)
Reasons for primary PNL failure	
Residual stones	43 (55.1)
Unsuitable access	9 (11.5)
Bleeding	8 (10.3)
Inadequate instruments	11 (141)
Pelvicalyceal perforation	4 (5.1)
Purulent urine	3 (3.8)

PNL, percutaneous nephrolithotomy.

Table 2 Operative data

Variables	Mean±SD/*n* (%)
Number of access tracts	
Single	64 (82.1)
Multiple (> 2)	14 (17.9)
Operative time	123±47.7
Postoperative drainage	
Nephrostomy tube	60 (76.9)
JJ stent	14 (17.9)
Ureteric catheter	4 (5.2)
Hospital stays	
Stone-free rate	3.5±1.1 (94.87)
	74
Complications	
Minor bleeding	3 (3.8)
Extravasation	2 (2.6)
Renal pelvic injury	3 (3.8)
Blood transfusion	5 (6.4)
Secondary procedure	
SWL	6 (7.7)
RIRS	3 (3.8)

RIRS, retrograde intrarenal surgery; SWL, shock wave lithotripsy.

In our study, we had a stone-free rate of 94.87%. Complications were graded according to the modified Clavien system. It was grade I in five patients [minor bleeding in three (3.8%) patients not necessitating blood transfusion, minor extravasation in two (2.6%) patients not necessitating stenting]. It was grade II in eight patients [renal pelvic injury in three (3.8%) required stenting and blood transfusion in five patients with bleeding more than 250 ccs (6.4%)].

Secondary procedures were required in nine (11.5%) patients to reach a stone-free status as determined by postoperative ultrasound; SWL in six (7.7%) patients and RIRS in three (3.8%). SWL was performed one month after the salvage PNL to ensure the adequate healing of the pelvicalyceal system while RIRS was performed before the patient's discharge. Stone-free status was estimated by noncontrast MSCT when the stone size was less than or equal to 3 mm [10]. Three out of the nine patients with a single 3 mm stone received medical treatment for one month with complete clearance.

As for the relationship between stone surface area and the need for the secondary procedure after PNL, we found that secondary procedures were required in 15% of stones less than or equal to 500 mm^2 if compared to 25% for stones 1000–1500 mm^2.

The stone compositions in our study were calcium oxalate monohydrate at 60%, calcium carbonate at 15%, uric acid stones at 10%, infection stones at 9%, and cystine stones at 6%.

A noteworthy finding in our study was the hard composition of the stones (81%) was noticed to facilitate the disintegration of the stones to large particles that could be traced and cleared easily through the pelvicalyceal system; either by direct visualization by nephroscope or easier localization under fluoroscopic guidance.

Discussion

PNL is a technically challenging surgical procedure with a high potential for morbidity [11]. The inherent complexity of the procedure has made it preferable to be performed in high-volume hospitals [12]. Despite the known potential for complications and treatment failure of PNL, little has been published regarding the fate of salvage PNL [7]. Prior studies demonstrated lower success rates with increasing the stone burden and complexity [13]. From a large cohort of over 1200 patients undergoing primary PNL, Borofsky *et al.* [7] found that the risk of PNL failure was closely related to the complexity of the stones rather than any identifiable patient factors. This was evidenced by the increased stone size and staghorn stone configuration in their salvage cohort.

The indications for second-look PNL is; bleeding necessitating termination of the procedure, perforation of the collecting system, prolonged operative time (>75 min) and failure to completely clear renal stones at the first attempt [14]. Residual calculi after PNL have been considered a Clavien grade III complication given the ancillary procedures required for stone clearance. However, CROES–Clavien Scoring System stated that, except for the occurrence of an intraoperative adverse event such as brisk hemorrhage leading to abrupt termination of the procedure exists, any residual fragments after the best-attempted trial should not be considered as a complication [15,16].

Regarding the relationship between stone surface area and the need for the secondary procedure after PNL, Turna *et al.* [13] found that secondary procedures were required in 15% of stones less than or equal to 500 mm^2 if compared to 25% for stones 1000–1500 mm^2. This was to our results where 32/54 patients had a stone surface area more than or equal to 1500 mm^2 (Table 3).

For the patient with significant residual fragments post-PNL, a second look at PNL has the potential to render them stone-free and reduce the future of stone-related events as justified by Kokov [10]. He performed salvage PNL in the outpatient facility using flexible PNL as an ambulatory procedure or in the operating room.

Our mean operative time was 123±47.7 min which is more than that Kumar and colleagues 88.6±31.1 min. This may be due to the high percentage of harder stones in our study. The number of punctures was single in 82.1% and multiple in 17.9%, while that of Kumar *et al.* [14], was 55% single punctures and 23% multiple punctures.

The low number of salvages PNL in our study was attributed to; experienced surgeons performing the

Table 3 Stone surface area

Stone surface area	Percentage
500 mm^2	4
500–1000 mm^2	18
>1500 mm^2	32

operations, the mean stone size of 3.7±1.2 cm, the location of the stones (pelvic 28.2%, pyelocaliceal 33.3%, and calyceal 38.5%). The position of stones in our study was noted to be a cause for salvage PNL or secondary procedures; mainly with pyelocaliceal and calyceal stones. The flexible nephroscope may solve this problem, especially for stones that are difficult to be approached rigid ones.

Second-look PNL can be performed during the same admission, and it ensures more complete clearance of complex stones with a lesser need for an adjunctive procedure like SWL as we did in our study. The mean hospital stays in our study of 3.5±1.1 days. This was in concordance with Borofsky *et al*. [7] who had a hospital stay of 3.1 days.

The stone-free rate was 94.87% in our series. We needed auxiliary procedures in nine (11.5%) patients, SWL in six (77%) patients, and RIRS in three (3.8%) patients. Kumar *et al*. [14] recorded secondary SWL in 12.8% after second look at PNL.

Complications after second-look PNL are comparable to those after primary PNL. Complications in our study included bleeding in 3.8%, extravasations in 2.6% renal pelvic injury in 3.8%, and blood transfusion in 6.4%. However, on second look PNL is associated with a prolonged hospital stay, the need for anesthesia, antibiotics, and increased chances of antibiotic resistance causing an economic load [14]. All of the reported complications in our work were Clavien I/II which is similar to that reported in Malkhasyan *et al*. [17] addressing that about 80% of the PNL complications belong to Clavien I/II.

Limitations of our study are its retrospective nature and being a single-center experience.

Salvage PNL remains an important tool for treating residual renal calculi. Harder, significant residual stones and intraoperative complications might be the predictors for the need to salvage PNL. To decrease the salvage rate, the primary procedure should be performed in a high-volume hospital with experienced surgeons in a well-equipped operative theater.

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Conflicts of interest
There are no conflicts of interest.

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