The outcome of percutaneous nephrolithotomy on ≥ 50 mm staghorn and multiple calyceal stones

Engin Kaya , Turgay Ebiloğlu , Murat Zor , Serdar Yalçın , Adem Emrah Coğuplugil , Selahattin Bedir

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ABSTRACT

Objective: To determine the success rate of percutaneous nephrolithotomy (PNL) in kidney stones over 50 millimeters.

Material and methods: Twenty-four patients with a renal stone size of >50 mm between January 2007 and December 2016 were enrolled. Stone-free and complication rates were investigated.

Results: Twenty-one (87.5%) patients were male and 3 (12.5%) were female. Fifteen (62.5%) stones were located in the right, and 9 (37.5%) in the left kidney. Twenty-one (87.5%) patients were operated using single-access, and three (12.5%) patients were double-access. Thirteen (54%) patients were found to have no stone after operation and 11 (46%) patients had residual stones. Extracorporeal shock wave lithotripsy was applied to 5 of 11 patients with residual stones, while flexible ureteroscopy was applied to 6 of them. After additional treatments, 8 (33.5%) patients were observed to be stone free. The stone-free rate was 87.5%. The mean operation time was 135.43 (85-240) minutes. Hemoglobin levels before and after operation were 14.8 (12-16.7) and 12.6 (9.3-15.5), respectively ($p=0.001$). The hospital stay was 6.04 (4-8) days. Complications were observed in four patients (16.6%).

Conclusion: PNL has high stone-free rate on staghorn type large stones compared with multiple calyceal scattered large stones.

Keywords: Percutaneous nephrolithotomy; stone; urolithiasis.

Introduction

Urinary system stone disease is observed quite frequently with a prevalence ranging between 1, and 20 percent.^[1] Size, and location of the stone, presence of concomitant pathologies, and related complications determine the degree of renal damage. Especially in large stones refractory to treatment, with time the risk of serious complications as loss of renal functions or life-threatening urosepsis increases. Without regarding the stone size, high stone-free rates decrease recurrence rates of stone disease.^[2]

Percutaneous nephrolithotomy (PNL) has strengthened its place in the management of

large kidney stones with high success, and lower complication rates.^[3] In recent years, minimally invasive surgical alternatives as extracorporeal shock wave lithotripsy (ESWL), flexible ureteroscopy (F-URS) have been used increasingly, PNL still retains its place in the management of large kidney stones.

As the stone size increases, number of access sites based on the location of the stone also change. As the number of access sites increases, complication rates, and especially risk of bleeding also increase.^[4] In recent years, decrease in the complication rates has been reported with the use of small sized access instruments.

Clinic of Urology, Gülhane
Training and Research
Hospital, Ankara, Turkey

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Correspondence:
Engin Kaya
E-mail:
drenginkaya@yahoo.com

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In this study we evaluated our results, and complications of PNL in patients who had staghorn stones or ≥ 50 mm-sized multiple stones in more than one calyces.

Material and methods

Following approval of the Ethics Committee of Dr. Abdurrahman Yurtaslan Ankara Oncology Education and Research Hospital, data of 24 patients who had undergone PNL for kidney stones larger than 50 mm between January 2007, and December 2016 were retrospectively evaluated.

Data concerning the preoperative examinations, tests, and imaging modalities routinely performed during preoperative period in our hospital for the evaluation of stone disease including physical examination findings especially costovertebral angle tenderness (CVAT), complete blood analysis (CBA), urine culture (UC), hemoglobin (Hb), serum urea, and creatinine values, plain urinary system graphy (KUB), computed tomography (CT), intraoperative fluoroscopy time (FT), duration of operation (OT), placement of JJ catheter, complication rate (CR) according to Clavien classification. Postoperative serum urea, and creatinine values, KUB data, and CT data obtained at postoperative 3. months, also duration of hospitalization and time to return to normal daily activities were recorded. Operative time was defined as the total time spent for insertion of cystoscope into bladder, advancing the guidewire through the ureter, placement of a ureteral catheter, laying the patient in the supine position, intracalyceal access using a percutaneous access needle, dilatation, and PNL using a nephroscope. The patients whose urine cultures demonstrated bacterial growth were treated with appropriate antibiotherapy, and sterile urine culture was maintained. All patients received antibiotic prophylaxis during induction phase of the operation using first generation intravenous cephalosporin or a quinolone. Stone-free status was defined as the absence of any residual stone as detected on KUB performed on the first postoperative day or CT realized at the 3rd postoperative month. Residual stones ≤ 4 mm, and > 4 mm were defined as insignificant, and significant residual stones, respectively.

Statistical analysis

Statistical analysis was performed using “Statistical Package for Social Sciences 20.0 software (IBM SPSS Statistics; Armonk, NY, USA)” program. Descriptive analysis was performed using mean (minimum, maximum), frequency, and percentages. Fitness of data to normal distribution was evaluated using Shapiro-Wilk, Kurtosis, and Skewness tests. Dependent continuous variables were compared using “The Wilcoxon” test. Stone-free rate (SFR) was evaluated with “chi-square test.” $p < 0.05$ was defined as the level of statistical significance.

Results

Twenty-one (87.5%) male, and 3 (12.5%) female patients were included in the study with an overall mean age of 35.6 ± 9.46 (21-71) years. CVAT positivity was detected on the side of the stone. Preoperatively, none of the patients had symptomatic urinary tract infection. Preoperatively, 13 (54%) patients with positive urine culture or urine analyses were treated with appropriate antibiotics. Mean stone diameter was estimated as 58.56 ± 8.46 (50-100) mm. The stones were localized in the right kidney in 15 (62.5%), and in the left kidney in 9 (37.5%) patients. PNL was performed. The patients were operated through single access ($n=21$; 12.5%) or double ($n=3$; 12.5%) access tracts. Mean (range) fluoroscopy, and operative times were estimated as 9.1 ± 7.1 (0.3-15.53), and 135.43 ± 37.53 (85-240) minutes. Clavien 1 ($n=3$; fever), and Clavien 2 ($n=1$; blood loss requiring blood transfusion) complications were also detected in indicated number of patients. Complication rate was calculated as 16.6 percent. At the end of the operation JJ catheters were used in all patients (Table 1).

Pre-, and postoperative levels of Hb, blood urea, and creatinine values were shown in Table 2. Median (range) hospital stay, and time to return to normal daily activities were 6.04 (4-8), and 9 (7-21) days, respectively.

On postoperative first day 13 (54%) patients were stone-free, and 11 (46%) patients had significant residual stones. Later on these 11 patients had undergone ESWL ($n=5$) or F-URS ($n=6$). Three months after additional treatments another 8 (33.3%) patients remained stone-free; while in 3 (12.5%) patients insignificant residual stone fragments were observed (Table 1). Overall stone-free rate was estimated as 87.5%.

On postoperative first day, 7 patients with staghorn stones were either stone-free ($n=6$; 85.7%) or had significant residual stone ($n=1$; 14.2%). Afterwards, the patient with significant residual stone underwent ESWL, and 3 months later stone-free status of the patient was observed. Seven (41.1%) out of 17 patients who had multiple stones remained stone-free on postoperative first day, while 10 (53%) of them had significant residual stones. Later on these 10 patients underwent ESWL ($n=4$) or F-URS ($n=6$). Three months after additional treatments another 7 (41.1%) patients remained stone free, while 3 (12.5%) of them had still insignificant residual stones. Stone-free rates of the patients with staghorn calculi staghorn calculi and multiple calyceal stones on the first postoperative day were 85.7, and 41.1% ($p=0.02$) respectively, while stone-free rates at 3. postoperative 3. months stone-free rates were calculated as 100, and 82.3%, respectively ($p=0.08$) (Table 3). No difference was detected between duration of hospitalization, time to return to normal daily activities, complication rates, operative and fluoroscopy times.

Table 1. General characteristics of the patients, and postoperative outcomes

Variable	Value
Laterality of the stone location	
Right	15 (62.5%)
Left	9 (37.5%)
Location of stone	
Renal pelvis	1 (4.1%)
Middle calyx	1 (4.1%)
Lower calyx	4 (16.6%)
Middle, and lower calyces	4 (16.6%)
Renal pelvis and lower calyx	7 (29.1%)
Staghorn stone	7 (29.1%)
Fluoroscopy time (min)	3.9±0.4
Operative time (min)	135.43±37.53
Complications	
Clavien 1	3 (12.5%)
Clavien 2	1 (4.1%)
Clavien 3a	0
Clavien 3b	0
Complication rate (%)	16.6
Stone-free rate (postoperative 1. day)	
Stone-free rate	13 (54%)
Insignificant residual stone	0
Significant residual stone	11 (46%)
Stone-free rate (postoperative 3. month)	
Stone-free rate	21 (87.5%)
Insignificant residual stone	3 (12.5%)
Significant residual stone	0
Hospital stay (days)	6.04 (4-8)
Time to return to normal daily activities (days)	9 (7-21)

Discussion

Firstly in the year 1976 Fernström reported percutaneous stone operation^[5], and within years PNL surpassed open surgery in the management of kidney stone. Nowadays, indications of retrograde intrarenal surgery have increased, and it is the standard treatment for kidney stones ≥ 2 cm in their largest diameter.

Since staghorn stones can not be eliminated completely, they have higher recurrence rates.^[6] Increased number or dimensions of stones bring with them more frequent interventions,

Table 3. PNL outcomes in staghorn or multiple calyceal stones

	Staghorn stones	Multiple calyceal stones
Number of patients	7	17
Stone-free rates		
Stone-free rate at a single session	6 (85.7%)	7 (41.1%)
Overall stone-free rate	7 (100%)	14 (82.3%)
Insignificant residual stone	0	0
Significant residual stone	1 (14.2%)	10 (58.8%)
Additional treatments		
ESWL	1 (14.2%)	4 (23.5%)
F-URS	0	6 (35.2%)
PNL	0	0
Complications		
Clavien 1	1 (14.2%)	2 (11.7%)
Clavien 2	0	1 (5.88%)
Clavien 3a	0	0
Clavien 3b	0	0

PNL: percutaneous nephrolithotomy; SWL: shock wave lithotripsy; F-URS: flexible ureterorenoscopy

Table 2. Pre-, and postoperative blood parameters, and radiological evaluation

	Preoperative	Postoperative 1. day	p*
Hb (g/dL)	14.8 (12-16.7)	12.6 (9.3-15.5)	0.0001
Urea (mg/dL)	28.17 (15-48)	27.6 (16-41)	0.19
Creatinine (mg/dL)	1.02 (0.71-1.53)	1.09 (0.62-1.59)	0.442
Stone observed on KUB	24 patients	13 patients (Stone-free rate 54%)	0.0001
Stone observed on CT	24 patients	3 patients (Stone-free rate 87.5%)	0.0001

Hb: hemoglobin; KUB: kidney-ureter-bladder; CT: computed tomography

higher number of complications, and lower stone-free rates. In a study by Akman et al.^[4] PNL was performed on 272 renal units because of the presence of staghorn kidney stone, and median stone-free rate at a single session was reported as 76.5%. More than one accesses were made into 102 (37.5%) units, while only a single access was made for 170 (62.5%) units. El Nahas et al.^[7] (n=241), and Desai et al.^[8] (1466) reported that they had achieved significant success rates (56.6, and 56.9%, respectively) at their first attempts in their PNL procedures performed to relieve kidney staghorn stones. However in our study, initial average stone-free rate for staghorn stones was estimated as 85.7%, while this rate decreased down to 41.1% for multiple calyceal stones. Overall average stone-free rate at first access was estimated as 54%.

Branching of the stone into all major calyces or presence of multiple calyceal stones require both multiple-access PNL, and additional treatments. According to the dimensions, and location of the stone recurrent PNL, ESWL or F-URS procedures may be applied. In a study, ESWL was performed for 29 patients after PNL, 3 patients received recurrent PNL, and another 3 patients underwent ureterorenoscopy.^[4] As additional treatments El Nahas et al.^[7] performed PNL in 30%, ESWL in 17%, and as previously unplanned treatment they used DJ implantation, ureteroscopy, and open surgery in 10.4% of their patients. In our study we performed ESWL in 5, and F-URS in 6 patients with residual kidney stones. At control visits scheduled for 3 months after additional treatments another 8 (33.3%) patients became stone-free, while in 3 (12.5%) patients had still insignificant residual stones. Overall stone-free rate was estimated as 87.5%. Even in kidney stones ≥ 50 mm lower success rates have been observed, additional treatments may increase success rates. With this approach, complication rates, and so morbidity rates are decreased. PNL application for single stones has higher success rates, and decreased requirement for additional treatments when compared with multiple calyceal stones. However comparable complication rates have been detected.

Most frequently seen complications of PNL are fever, bleeding, urine leakage, and presence of residual stones.^[1] In a study by Akman et al.^[4] a total of 77 complications were observed in 64 patients. The most frequently seen complication was bleeding, and angioembolization was performed in 2 out of 47 patients because of development of pseudoaneurysm, and arteriovenous fistula. In their series of 119 patients Netto et al.^[9] observed complications in 28.5% of their patients including blood transfusion requiring bleeding (n=25), pneumothorax-hydrothorax (n=2), sepsis-bacteremia (n=2), ileus (n=2), and prolonged urine leakage (n=2). In our study, we detected Clavien 1 (fever) (n=2), and Clavien 2 (blood transfusion requiring bleeding) (n=3) complications in respective number of patients. Overall complication $\pm$ as detected as 16.6%.

In PNL, as the number of interventions increase, risk of complications also increases. In cases with larger kidney stones, recurrent PNL procedures or application of additional treatments as ESWL, and F-URS increase stone-free rates with lower complication rates.

Limited number of patients, and retrospective design of our study constitute the most important limitations of our study. Despite use of tubeless techniques recently, because of large size of the stones we applied nephrostomy together with DJ catheter in all of our cases.

In conclusion, although multiple number of accesses, necessity of additional treatments, and increase in complication rates are observed, PNL is an effective, and reliable treatment alternative in the management of kidney stones ≥ 50 mm in size. With evolving PNL techniques, and tubeless methods, stone-free rates increase, while hospital stays, and operative times gradually shorten. PNL achieves higher stone-free rates in the management of large staghorn stones when compared with multiple calyceal stones.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital (Date: 04 Jan.2017, number:2017-01/01).

Informed Consent: Written informed consent was obtained from all patients who participated in this study.

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