Outcome of percutaneous nephrolithotomy for renal stones in Assiut Urology and Nephrology Hospital

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Context
Percutaneous nephrolithotomy (PCNL) has become the standard treatment for renal stones not amenable to extracorporeal shock wave lithotripsy in many countries.

Aims
The current study aims to evaluate the outcome of PCNL, in terms of efficacy and success rate, in the management of renal stones in our hospital.

Settings and design
This is a descriptive case-series study.

Patients and methods
A total of 230 patients, 173 men and 57 women underwent PCNL in our hospital between September 2013 and September 2015. The following clinical parameters were reported; stone site, size, serum creatinine, operative time, site of calyceal puncture, number of tracts, decrease in hemoglobin level, length of hospital stay, stone-free rate (SFR), and complications.

Statistical analysis used
Intercooled STATA, version 9.2 was used. χ-Test or Fisher's exact test was used for comparison of the categorical data and Mann–Whitney *U*-test used to compare the noncategorical data.

Results
The median age was 38 years (range: 3–75 years). The mean operative time was 110 ± 30 min, and hospital stay ranged from 2 to 8 days. The primary SFR was 70.9% after the first session of PCNL but the overall clearance was 87.7%. It was found that stone location, access puncture, access number, and operative time were statistically significant factors affecting SFR. The overall complications were 13%.

Conclusion
PCNL is considered a standard treatment for large renal stones. Stones distribution, access puncture, number of access, and operative time significantly affect the SFR. The usage of flexible nephroscope and a second-look nephroscopy improved the outcome.

Keywords:
extracorporeal shock wave lithotripsy, flexible nephroscope, percutaneous nephrolithotomy, renal stones

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Introduction

In an active urological department, 30% of the surgical working load is related to the treatment of renal and ureteral stones [1]. Since its introduction by Fernstrom and Johansson [2], percutaneous nephrolithotomy (PCNL) has been practiced by many urologists.

Local factors, availability, and experience clearly influence the application of PCNL [3]. Staghorn morphometry is a new prognostic tool to predict the outcome of PCNL [4]. Numerous scoring systems developed to predict the results of PCNL especially stone-free rate (SFR) [5,6]. The current study aims to evaluate the outcome of PCNL in our department.

Patients and methods

This is a descriptive case series study targeting all patients with renal stones: unilateral or bilateral, single or multiple, pelvic or calyceal, primary or recurrent, of both sexes, both adults, and pediatric patients attending our outpatient clinic between September 2013 and September 2015.

All patients underwent a detailed history and physical examination, and BMI measurement. Laboratory investigations include urinalysis, renal function tests, complete blood picture, bleeding and coagulation profile, and blood sugar level.

Plain kidney ureter bladder, ultrasonography, and noncontrast computed tomography were performed for all patients. Computed tomography urography

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was performed for complex renal stones, anatomic abnormalities, and for obese patients. Patients underwent evaluation of the anesthetic risk according to the American Society of Anesthesiologists classification of physical status.

Under general or spinal anesthesia, ureteral catheter 6 Fr was introduced. After that, the patient was positioned in the prone position. The renal access was created under fluoroscopy using the bull's eye or triangulation techniques. Tract dilation was performed using a balloon dilator, the Alken dilators system, or coaxial teflon dilators up to 30 Fr. In cases of planned multiple tracts, multiple punctures were done and guide wires were introduced first, followed by establishment of the tracts according to the progress of the operation.

Stones were disintegrated by a pneumatic lithoclast or an ultrasonic disintegrator. Small fragments were also washed out with hydrodynamic effects. At the end of the procedure, a 22 Fr. plastic catheter was inserted through the Amplatz sheath to the renal pelvis together with the ureteral catheter or JJ stent.

Postoperative plain kidney ureter bladder, renal ultrasonography, hemoglobin level, and hematocrit value were routinely performed. Noncontrast computed tomography was performed if there were residual stones which required the second look. The grade of complication was determined on the basis of the Clavien classification and its modification for percutaneous procedures.

If the patient was stone free, the nephrostomy tube was removed by the first postoperative day and the ureteral stent removed once urinary leakage stopped. If there were residual stones, second-look PCNL was performed, sometimes extracorporeal shock wave lithotripsy (ESWL) was an option.

Statistical analysis was performed using intercooled STATA, version 9.2 (StataCorp., College Station, Texas, USA). The analysis included the χ^2-test or Fisher's exact test for comparison of the categorical data, and the Mann–Whitney *U*-test (values expressed as median, interquartile range) compare the noncategorical data.

Results

A total of 230 patients underwent PCNL; their preoperative patients' characteristics are summarized in Table 1. Recurrent cases (previous open surgery, had previous SWL or PCNL) were reported in 87 (37.8%). Only two procedures were done for patients with solitary kidney. Regarding renal function, we have five (2.17%) cases with chronic kidney disease. Most of the procedures were finished with a single access 200 (87%) cases, two in 29 (12.6%) cases, and three tracts in one (0.4%) case. Table 2 shows the access site and distribution.

For tract dilation balloon dilatation used in 164 (71.3%) cases, 66 (28.7%) cases used coaxial Teflon dilators. Pneumatic disintegrator was used in 194 (84.3%) cases, ultrasonic in 34 (14.8%) cases, and laser in two (0.9%) cases. We used both nephrostomy tube and ureteral stent for drainage in the majority of cases [196 (85.2%)], JJ stent left in 30 (13.1%) cases, and nephrostomy-less in four (1.7%) cases. Our mean operative time was (mean ± SD) 110 ± 30 min.

After the first session of PCNL procedure, 163 (70.9%) cases were rendered stone free (with residual fragments ≤4 mm) and 67 (29.1%) cases had residuals. ESWL was performed for 32 (47.8%) cases with residual stones, 10 cases of them rendered stone free post-ESWL. Second-look PCNL was performed for 34 (50.8%) cases, 25 cases of them were rendered stone free. Three cases rendered stone free after second look and ESWL. One case only underwent ureterorenoscopy for migrating stones. Our overall clearance of PCNL (patients who became stone

Table 1 Preoperative characteristics of patients

Characteristics	Results
Age [median (range)] (years)	38 (3-73)
Sex [*n* (%)]	
Male	173 (75.2)
Female	57 (24.8)
Hb (g/dl) (mean±SD)	12.2±1
BMI (kg/m^2)	26.2±5.6
Stone site [*n* (%)]	
Right	121 (52.6)
Left	109 (47.4)
Stone size (mean±SD)	3.5±1.1
Stone complexity [*n* (%)]	
Single	92 (40)
Multiple	138 (60)
HF unit (mean±SD)	1107.6±191.3

Hb, hemoglobin; HF, Hounsfield unit.

Table 2 Number and distribution of the access puncture

Access puncture	Results
Single [*n* (%)]	200 (86.9)
Lower calyx	157 (68.3)
Middle calyx	31 (13.5)
Upper calyx	12 (5.2)
Multiple [*n* (%)]	30 (13.1)
Lower calyx and middle calyx	17 (7.4)
Lower calyx and upper calyx	3 (1.3)
Upper calyx and middle calyx	9 (3.9)
Upper calyx, middle calyx, and lower calyx	1 (0.4)

free after PCNL plus patients who became stone free after the auxiliary procedures) was 202 (87.8%) cases.

The reported complications according to the modified Clavien–Dindo grading system and their management are summarized in Table 3. The mean decrease of hemoglobin was 1.8 ± 1.1 g/dl. The median hospital stay was 3.8 days (range: 2–8 days).

On univariate analysis, it was found that age, stone size, Hounsfield unit (HU unit), complexity, pelvic stones, lower calyceal stones and staghorn stones, recurrence, access puncture, number of accesses, and operative time were significant factors affecting SFR. While multivariate analysis found that presence of stones in the pelvis, the presence of stones in the lower calyx and staghorn stones, access puncture, number of accesses, and operative time were significant factors affecting SFR as shown in Table 4.

Table 3 Complications reported

Grades	Complication	*n* (%)	Management
II	Intraoperative bleeding	18 (7.8)	Transfusion
I	Postoperative fever	10 (4.3)	Conservative
IIIb	Perforation of PCS (IPF collection)	2 (0.87)	Sab drainage
IIIb and IVa	Postoperative hemorrhage	2 (0.87)	One embolization and one nephrectomy
IIIb	Urine leakage	4 (1.7)	JJ stent insertion

IPF, intraperitoneal fluid collection; PCS, pelvicalyceal system.

Table 4 Univariate and multivariate analysis to assess the predictors of SFR in percutaneous nephrolithotomy

Variables	Unstandardized[a]		Standardized[b]	
	ODDs (95% CI)	*P*	ODDs (95% CI)	*P*
Age	1.03 (1.01-1.05)	0.002**	1.02 (0.99-1.06)	0.166
BMI	1.3 (1.032-1.7)	0.005**	1.12 (0.72-1.93)	0.523
Stone size	2.44 (1.77-3.34)	<0.001**	1.67 (0.98-2.88)	0.062
HF unit	1.002 (1-1)	0.037*	1 (1-1)	0.313
Complexity				
Single	1 (Reference)		1 (Reference)	
Multiple	5.23 (2.5-10.95)	<0.001**	0.89 (0.16-4.97)	0.896
Location				
Pelvis	0.42 (0.2-0.89)	0.024*	0.27 (0.1-0.52)	0.013*
Staghorn	4.1 (1.67-10.17)	0.002**	6.3 (3.33-9.29)	0.001**
Lower calyx	0.05 (0.003-0.83)	0.036*	0.03 (0.001-0.62)	0.016*
Access puncture				
Lower calyx and middle calyx	1.45 (0.48-4.4)	0.509	0.1 (0.02-0.52)	0.006**
Number of accesses				
1	1 (Reference)		1 (Reference)	
2	2.25 (1.02-4.99)	0.045*	2.31 (1.11-4.25)	0.033*
Operative time	36 (11.1-116.9)	<0.001**	24.73 (4.45-137.45)	<0.001**

CI, confidence interval; ODD, odds ratio. [a]Univariate analysis. [b]Multivariate analysis. *Statistically significant predictor ($P<0.05$).**Statistically significant predictor ($P<0.01$).

Discussion

Currently, PCNL is considered the gold standard treatment for renal stones that are larger than 2 cm due to the high success rate and relative minimal morbidity [7]. However, in developing countries the incidence of open stone surgery is still high [8].

BMI in our study did not affect postoperative outcomes. This is in agreement with several authors who found no significant difference between obese and nonobese patients in the operative time, SFR, and complications rates [9]. However, in a large multicenter study obese patients had longer operative time, inferior SFR, associated with increased risk of severe bleeding [10].

Turna *et al.* [11] using a combination of stone surface area and stone type (pelvic, calyceal, multiple with pelvic dominant, and multiple with calyceal dominant) found that both increased surface area and presence of multiple calyceal dominant stones were associated with lower SFR.

It had been found that a lower HU is associated with failure of PCNL maneuver (less radio-opacity); this is also the same with very high HU (hard stones). The ideal stones for PCNL had been determined to have 1250 HU which has the highest success rate [12]. Our study showed no significant difference between HU and SFR.

In a recent study, Yesil *et al.* [13] had shown that previous open renal surgery increased vascular complications in patients undergoing PCNL. With multivariate analysis our study showed that previous surgery did not affect the outcomes of the PCNL procedure.

According to the number of tracts encountered during PCNL, performing PCNL for large and complex stones with a single access had proved to be effective and has the same range of success of the procedure in the literature [14]. Hegarty and Desai [15] had found similar results in a comparison between single and multiple tracts; however, they noticed that there is a significant rise in serum creatinine for the multiple tracts group. On the contrary, other authors who use the glomerular filtrate rate estimation concluded that there is no difference in renal function between single and multiple tracts [16]. The number of tracts which were done in our study ranged from one to three per renal unit and significantly affects the SFR.

Operative time is an important factor that can affect the PCNL procedure. In the CROES study with nearly 6000 patients from multiple centers, they classify operative duration to short (<50 min), medium (51–75 min), long (76–115 min), and very long (>116 min) [17]. Long operative time increases the duration of anesthesia and may risk postoperative pulmonary complications [18]. Also it increases blood loss, the need for transfusion and overall complication rates [19]. In addition, short operative time is important because it is cost effective [20].

In our study, the mean operative time was in the longtime group. There are many preoperative factors that might lead to this result (stone burden, stone location, and previous maneuvers). It had been found that several factors affect the operative time with different results among different studies, for example, history of open surgery, the presence of hydronephrosis, stone type, stone burden, surgical experience, BMI, type of imaging for access and calyx for access significantly affect the operative time [21].

Recently published research by El-Nahas and Shokeir [22] compared between tubeless PCNL and leaving the nephrostomy for one night and concluded that the nephrostomy tube significantly decreases the complications rate without affecting the analgesic requirements and hospital stay. In our study, we left nephrostomy tube in the majority of patients and there was no significant correlation between leaving nephrostomy tube and the complications reported.

Regarding hospital stay, in a study comparing experienced surgeons in PCNL with a less experienced one, hospital stay was significantly shorter for the experienced one 6.5 versus 9.9 days [23]. Others identified the risk factors that affect the length of hospital stay such as the presence of preoperative comorbidities, raised preoperative creatinine, large stone burden, access puncture, number of accesses, and type of anesthesia and exit strategy [24]. In our study, the relatively long hospital stay was due to the arrangement for the second look and other auxiliary procedures.

Abdelhafez *et al.* [25] found that presence of upper calyceal stone, staghorn stone, a multiplicity of stones, previous PCNL, preoperative creatinine, stone burden, number of punctures, a method of dilatation, and operative time significantly affect the SFR in univariate analysis. Multivariate analysis of our results found that the presence of stones in the pelvis, the presence of stones in the lower calyx and staghorn stones, access puncture, number of accesses, and operative time were significant factors affecting SFR.

The outcome of PCNL requires not only success rate but also complication rates. There are many factors that are associated with increased complications' rate including patients with coagulopathies, positive urine culture, complex stones, multiple access punctures, and longer operative time [26].

The CROES PCNL Global Study data obtained from 5803 patients at 96 study centers reported that about 20.5% of patients experienced one or more complications and 48.2% by Siemens *et al.* [27,28]. In our study, the overall complications were evident in 13% of patients and blood transfusion and fever were the commonest.

We have some limitations in our study such as the descriptive design (no control), the use of flexible nephroscope to survey the calyces was not the protocol, and scoring systems were not applied.

We recommend the usage of stone morphometry for preoperative prediction of stone clearance, scoring systems for the evaluation of outcome, and SFR and routine use of flexible nephroscope when available.

PCNL is now considered as the standard treatment for large and complex renal stones. Stones distribution, access puncture, number of access, and operative time significantly affect the SFR. The usage of flexible nephroscope and second-look nephroscopy improved the outcome.

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Conflicts of interest

There are no conflicts of interest.

References

1 Pearle MS, Calhoun EA, Curhan GC. Urological diseases in America project: urolithiasis. J Urol 2005; 173:848–857.

2 Fernstrom I, Johansson B. Percutaneous pyelolithotomy. A new extraction technique. Scand J Urol Nephrol 1976; 10:257–259.

3 Ghani KR, Andonian S, Bultitude M, Desai M, Giusti G, Okhunov Z, *et al*. Percutaneous nephrolithotomy: update, trends, and future directions. Eur Urol 2016; 70:382–396.

4 Mishra S, Sabnis RB, Desai MR. PCNL monotherapy for staghorn: paradigm shift for 'staghorn morphometry' based clinical classification. Curr Opin Urol 2012; 22:148–153.

5 Thomas K, Smith NC, Hegarty N, Glass JM. The Guy's stone score: grading the complexity of PCNL procedures. Urology 2011; 78:277–281.

6 Smith A, Averch TD, Shahrour K, Opondo D, Daels FP, Labate G, *et al*. A nephrolithometric nomogram to predict treatment success of percutaneous nephrolithotomy. J Urol 2013; 190:149–156.

7 Türk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub M, Seitz C. EAU guidelines on urolithiasis. Arnhem: European Association of Urology; 2010

8 El-Husseiny T, Buchholz N. The role of open stone surgery. Arab J Urol 2012; 10:284–288.

9 Tomaszewski JJ, Smaldone MC, Schuster T, Jackman SV, Averch TD. Outcomes of PCNL stratified by body mass index. J Endourol 2010; 24:547–550.

10 Fuller A, Razvi H, Denstedt JD, Nott L, Pearle M, Cauda F, *et al*. The CROES PCNL global study: the influence of body mass index on outcome. J Urol 2012; 188:138–144.

11 Turna B, Umul M, Demiryoguran S, Altay B, Nazli O. How do increasing stone surface area and stone configuration affect overall outcome of percutaneous nephrolithotomy? J Endourol 2007; 21:34–43.

12 Anastasiadis A, Onal B, Modi P, Turna B, Duvdevani M, Timoney A, *et al*. Impact of stone density on outcomes in PCNL (PCNL): an analysis of the clinical research office of the endourologicalal society (CROES) PCNL global study database. Scand J Urol 2013; 47:509–514.

13 Yesil S, Ozturk U, Goktug HN, Tuygun C, Nalbant I, Imamoglu MA. Previous open renal surgery increased vascular complications in PCNL (PCNL) compared with primary and secondary PCNL and extracorporeal shock wave lithotripsy patients: a retrospective study. Urol Int 2013; 91:331–334.

14 Shalaby MM, Abdalla MA, Aboul-Ella HA, El-Haggagy AM, Abd-Elsayed AA. Single puncture percutaneous nephrolithotomy for management of complex renal stones. BMC Res Notes 2009; 2:62.

15 Hegarty NJ, Desai MM. PCNL requiring multiple tracts: comparison of morbidity with single-tract procedures. J Endourol 2006; 20:753–760.

16 Handa RK, Evan AP, Willis LR, Johnson CD, Connors BA, Gao S, *et al*. Renal functional effects of multiple-tract percutaneous access. J Endourol 2009; 23:1951–1956.

17 Labate G, Modi P, Timoney A, Cormio L, Zhang X, Louie M, *et al*. On Behalf Of the Croes Pcnl Study Group J. The PCNL global study: classification of complications. J Endourol 2011; 25:1275–1280.

18 Scholes RL, Browning L, Sztendur EM, Denehy L. Duration of anesthesia, type of surgery, respiratory co-morbidity, predicted $VO_{2\ max}$ and smoking predict postoperative pulmonary complications after upper abdominal surgery: an observational study. Aust J Physiotherapy 2009; 55:191–198.

19 Akman T, Binbay M, Sari E, Yuruk E, Tepeler A, Akcay M, *et al*. Factors affecting bleeding during percutaneous nephrolithotomy: single-surgeon experience. J Endourol 2011; 25:327–333.

20 Akman T, Binbay M, Akcay M, Tekinarslan E, Kezer C, Ozgor F, *et al*. Variables that influence operative time during percutaneous nephrolithotomy: an analysis of 1897 cases. J Endourol 2011; 25:1269–1273.

21 Cormio L, Preminger G, Saussine C, Buchholz NP, Zhang X, Walfridsson H, *et al*. Nephrostomy in PCNL: does nephrostomy tube size matter? Results from the Global PCNL Study from the Clinical Research Office Endourology Society. World J Urol 2013; 31:1563–1568.

22 El-Nahas AR, Shokeir AA. Percutaneous nephrolithotomy: keeping the bridge for one night. Urol Res 2012; 40:389–393.

23 Huang WY, Wu SC, Chen YF, Lan CF, Hsieh JT, Huang KH. Surgeon volume for PCNL is associated with medical costs and length of hospital stay: a nationwide population-based study in Taiwan. J Endourol 2014; 28:915–921.

24 Matlaga BR, Hodges SJ, Shah OD, Passmore L, Hart LJ, Assimos DG. Percutaneous nephrostolithotomy: predictors of length of stay. J Urol 2004; 172(Pt 1):1351–1354.

25 Abdelhafez MF, Wendt-Nordahl G, Bedke J, Amend B, Honeck P, Stenzl A, *et al*. Minimally invasive versus conventional large-bore percutaneous nephrolithotomy in the treatment of large-sized renal calculi: Surgeon's preference? Scand J Urol 2016; 50:212–215.

26 Tyson MD, Humphreys MR. Postoperative complications after percutaneous nephrolithotomy: a contemporary analysis by insurance status in the United States. J Endourol 2014; 28:291–297.

27 De la Rosette J, Assimos D, Desai M, Gutierrez J, Lingeman J, Scarpa R, *et al*. The Clinical Research Office of the Endourologicalal Society PCNL Global Study: indications, complications, and outcomes in 5803 patients. J Endourol 2011; 25:11–17.

28 Semins MJ, Bartik L, Chew BH, Hyams ES, Humphreys M, Miller NL, *et al*. Multicenter analysis of postoperative CT findings after percutaneous nephrolithotomy: defining complication rates. Urology 2011; 78:291–294.