Percutaneous nephrolithotomy for renal stones in chronic kidney disease and poorly functioning kidney: a prospective study

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Introduction
Removal of stone in patients with coexistent renal insufficiency improves the function of the kidney in most of the cases. Percutaneous nephrolithotomy (PCNL) is considered a suitable minimally invasive treatment option in these patients with minimum morbidity and mortality.

Patients and methods
This was a prospective study conducted in Assiut University Hospital, Egypt, from March 2015 to March 2018 to assess the efficacy and safety of PCNL in patients with chronic kidney disease (CKD) and patients with unilateral poorly functioning kidney (UPFK). The authors recruited patients aged greater than or equal to 18 years, with renal stone with either CKD or UPFK. All patients were managed with PCNL. Primary outcomes were stone clearance and complications rates. Secondary outcomes were serum creatinine and estimated glomerular filtration rate. Data collected were analyzed using Statistical Package for the Social Sciences 20 software. *P* value was considered significant if less than or equal to 0.05.

Results
At early follow-up (1 month postoperatively), the stone clearance rate was 54.8% (23 patients) and at late follow-up (3 months postoperatively), it was 61.9% (26 patients). Intraoperative complications occurred in six (14.3%) patients; intraoperative bleeding managed by blood transfusion (four patients), and pelvicalyceal system perforation was managed by double-J stent insertion (two patients). Postoperative complications occurred in 17 (40.5%) patients, mainly low-grade fever in eight (19%) patients.

Conclusion
PCNL has favorable outcomes in patients with CKD and patients with UPFK regarding complete stone clearance rates. Safety of PCNL and postoperative renal function improvement remain questionable for further studies.

Keywords:
chronic renal disease, complications, percutaneous nephrolithotomy, renal stone

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Introduction

Urolithiasis is a common health condition with significant economic burden on societies and deleterious effect on quality of life. Its prevalence is estimated to be from 7 to 13% [1]. In developing countries, patients are usually presented with large sized renal stones. In chronic obstruction, infection follows, leading to renal failure in case of bilateral renal damage. It is suggested that 0.2–3.2% of patients with renal stones have end-stage renal disease (ESRD) [2].

The emergence of extracorporeal shockwave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), and ureterorenoscopy has altered dramatically the management of urolithiasis. In fact, these treatment modalities have nearly 99% success rates for treatment of upper urinary tract stones [3]. Indications of PCNL include large or complex stones, failed SWL, residual stones, and abnormal renal anatomy [4]. Regarding safety of PCNL, it is considered a safe and efficient procedure with low rate of complications such as infection, hemorrhage, and injury to adjacent organs [5,6].

Furthermore, it was found that removal of renal calculi improves renal function in chronic kidney disease (CKD), especially those with mild renal insufficiency [1,4,7].

In this study, we aimed to assess safety and efficacy of PCNL in patients with CKD and patients with unilateral poorly functioning kidney (UPFK).

Patients and methods

This was a prospective hospital-based (self-controlled) clinical trial that was conducted in Urology and Nephrology University Hospital, Assiut university, Assiut, Egypt. Patients aged greater than or equal to 18 years who attended the endourology outpatient clinic from March 2015 to March 2018 and experienced obstructing renal stones with size greater than 1 cm were evaluated for inclusion in our study.

All patients recruited in our study were managed with standard PCNL technique. We included adult patients aged greater than or equal to 18 years who had either renal stones and CKD [total glomerular filtration rate (GFR) not more than 60 ml/min/1.73 m^2] or renal stones and UPFK (its GFR not more than 30 ml/min/1.73 m^2 measured by renal radioisotope scan). Exclusion criteria were uncontrolled coagulation disorders, active urinary tract infection, nonobstructing calyceal stones or renal stones in ectopic pelvic, transplanted kidney, pregnancy, and patients who were unfit or refused PCNL. Informed written consent was obtained from each participant of the study. Ethical approval was obtained from the Medical Ethics Committee of Scientific Research in Faculty of Medicine, Assiut University (IRB no. 17200479).

The following domains were collected and analyzed from each patient of the study: age, sex, BMI, body surface area (BSA), previous surgical procedures, medical comorbidities, urinary tract infection, hemoglobin level (Hgb) (g/dl), and operative details. Main primary outcomes included the following: first, stone-free rate or stone clearance at early follow-up (1 month postoperatively) and late follow-up (3 months or more), and second, complications, which included all intraoperative and postoperative complications. Postoperative complications were recorded according to modified Clavien-Dindo (CD) classification during the period of hospital stay [8]. Secondary outcomes included evaluation of estimated glomerular filtration rate (eGFR) and serum creatinine early and late postoperatively in patients with CKD. We measured eGFR in patients with CKD using Cockcroft-Gault formula adjusted for the individual BSA (CG-BSA) as follows [9,10]:

(140-age)×weight×(0.85 if female)/(72×SCr), adjusted for BSA by 1.73m^2/BSA

Operative technique

The operation was done under general anesthesia with patients in prone position. We used fluoroscopic guidance through the posterior calyx to access the kidney as this route enables maximal stone clearance with minimal complications. The tracts were dilated using sequential Amplatz dilators or balloon dilators up to 30 F. According to stone size, number, and shape and renal anatomy, the number of tracts were determined. We used both pneumatic lithotripsy and stone forceps for stone clearance. At the end of the operation, and if needed, 18-F nephrostomy tube was inserted. Plain radiographic KUB film and ultrasound were done first day postoperatively. Early (1 month postoperatively) and late (three months or more) postoperative follow-ups were done.

Statistical analysis

Data collected were analyzed using Statistical Package for Social Sciences (version 20; SPSS Inc., Chicago, Illinois, USA).

For quantitative data, independent samples *t*-test and Mann–Whitney *U*-test were used for normally and not normally distributed data, respectively. For qualitative data, we used χ^2 and Fisher's exact tests (if one of the numerical values < 5). *P* value was considered significant if less than or equal to 0.05.

Results

A total of 42 patients, comprising 21 patients with CKD and 21 patients with UPFK underwent standard PCNL. Age, sex, BMI, BSA, previous procedures on the same side of intervention, comorbidities, preoperative urinary tract infection, and preoperative Hgb are shown in Table 1.

Median operative time for all patients was 75 (30–105) min. The operative time was significantly longer in cases that underwent multiple accesses, with mean operative time 92.9 ± 9.1 min, than those that underwent single renal access, with mean operative time of 70.7 ± 20.5 min ($P < 0.001$).

At early follow-up (1 month postoperatively), the stone-free rate or complete stone clearance in all 42 patients was 54.8% (23 patients) and at late follow-up (3 months postoperatively), it was 61.9% (26 patients, including 16 (76.2%) patients with CKD and 10 (47.6%) patients with UPFK. The rest 16 patients who were not cleared from stones had significant residual stones. Five of them underwent SWL (1–3 sessions), which failed to render them completely free from stones at 6-month follow-up, whereas 11 patients refused to have further therapy.

Intraoperative and postoperative complications occurred in 23 (54.8%) patients. Intraoperative complications (managed intraoperatively with normal postoperative course) occurred in six (14.3%) patients.

These included four cases that had intraoperative bleeding managed by blood transfusion and two cases that had intraoperative pelvicalyceal system perforation at ureteropelvic junction (UPJ) (site of stone impaction) and managed by double-J stent (DJ) insertion, with postoperative course showing no UPJ obstruction.

Postoperative complications occurred in 17 (40.5%) patients. These complications were classified according to the modified Clavien-Dindo (CD) classification [8] into the following:

(1) Eight (19%) patients had grade 1: all experienced low-grade postoperative fever managed conservatively.
(2) Seven patients (16.7%) had grade 2:
(a) Two cases experienced postoperative high-grade fever managed conservatively.
(b) Two cases experienced postoperative gross hematuria managed conservatively.
(c) One case experienced postoperative high-grade fever, gross hematuria, and urinary leakage managed conservatively.
(d) One case experienced postoperative gross hematuria and urinary leakage managed conservatively.
(e) One case experienced postoperative gross hematuria and high-grade fever managed conservatively.
(3) Two (4.8%) patients had grade 3a:
(a) One case, a 35-year-old male patient, experienced postoperative urinary leakage and gross hematuria managed operatively – during failed trial of second look from the same access for residual lower calyceal stone – with DJ insertion for leakage and further SWL of the residual stone.
(b) The other case, a 55-year-old male patient, experienced postoperative urinary leakage, persistent high-grade fever, gross hematuria, and raised renal chemistry owing to impacted residual UPJ stone of the better functioning left kidney managed operatively by DJ insertion.

Regarding secondary outcomes in patients with CKD, although early follow-up showed significant deterioration of the eGFR with consequent significant increase in serum creatinine level, late follow-up showed insignificant improvement in eGFR and insignificant improvement in the serum creatinine level (Table 2).

Discussion

Recently, there has been increased association between renal stones and CKD and even ESRD. The presence

Table 1 Patients' characteristics

Characteristics	CKD patients (*n*=21)	UPFK patients (*n*=21)
Age (years) [median (range)]	55 (24-69)	31 (19-60)
Sex (male : female)	14 : 7	11 : 10
Previous procedure on the same side		
Surgery	6	9
SWL	1	-
URS	1	-
PCN	5	1
DJ	2	-
Comorbidities		
Diabetes	3	3
Hypertension	6	-
Hyperlipidemia	-	1
IHD	2	-
BMI [median (range)]	25.8 (20.1-30.5)	24.5 (19.6-36.6)
BSA (mean±SD)	1.8±0.2	1.7±0.2
Preoperative urinary tract infection (positive urinary culture) [*n* (%)]	16 (76.2)	11 (52.4)
Preoperative Hgb (g/dl) [median (range)]	12.3 (9.8-16.6)	12.2 (11.2-15.6)

BSA, body surface area; CKD, chronic kidney disease; DJ, double-J stent; Hgb, hemoglobin; IHD, ischemic heart disease; PCN, percutaneous nephrostomy; SWL, shockwave lithotripsy; UPFK, unilateral poorly functioning kidney; URS, ureterorenoscopy.

Table 2 Renal function in CKD patients

Characteristics	Preoperative	Postoperative	*P*
Preoperative vs early postoperative serum creatinine [median (range)] (mg/dl)	1.8 (1.1-4.2)	2.3 (1.1-5.5)	<0.0001*
Preoperative vs early postoperative eGFR by adjusted CG formula (mean±SD) (ml/min/1.73 m^2)	43.2±11.9	36.9±12.7	0.001*
Preoperative vs late postoperative serum creatinine [median (range)] (mg/dl)	1.8 (1.1-4.2)	1.6 (1-5.3)	0.16
Preoperative vs. late postoperative eGFR by adjusted CG formula (mean±SD) (ml/min/1.73 m^2)	43.2±11.9	45.3±13.9	0.249

Adjusted CG formula, Cockcroft-Gault formula; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate. *Statistically significant ($P \leq 0.05$).

of coexisting medical conditions such as hypertension and anemia in patients with CKD makes them more liable to operative and postoperative complications and decreased success rate of stone removal [2]. Although the success of PCNL in patients with normal functioning kidneys has been established, the safety and efficacy of PCNL in cases with renal insufficiency remains to be elucidated [7]. Therefore, sufficient surgical training and multidisciplinary team work including endourologists, hematologists, and nephrologists are mandatory for preparing patient-tailored management plan in cases of CKD and ESRD [7].

Our study included 42 patients (21 with CKD and 21 with UPFK) who underwent standard PCNL and prospectively evaluated. For all patients, the stone-free and complications rates were 61.9 and 54.8%, respectively.

Our median operative time for all 42 patients was 75 (30–105) min. We noticed that patients who had undergone multiple accesses had significantly longer operative time than those who had undergone single renal access. For CKD patient group, the median operative time was near to that reported by Akman *et al*. [11] and Ozden *et al*. [12], whereas it was shorter than that recorded by Bilen *et al*. [13] who found that longer operative time was related to complicated stones; however, Sariam *et al*. [14], reported significantly longer operative time in patients with CKD stages IV/V than other CKD stages, but in our study, we did not have patients with stage V.

Regarding stone clearance or stone-free rate, at three months postoperatively after PCNL, we found that complete stone clearance or stone-free rate not aided by auxiliary maneuvers, whether SWL or ureteroscopy, was 61.9% (26 patients) of all 42 patients included in our study, whereas for CKD and UPFK patient groups were 76.2% (16 patients) and 47.6% (10 patients), respectively. For CKD patient group, this was near to the rates observed by previous studies [15,16].

We considered patients as clear of stones in the absence of any significant stone fragments greater than 4 mm on postoperative radiograph and abdominal ultrasound. The high stone clearance rates observed in our study, especially at 3 months postoperatively, may be explained by the use of a flexible nephroscope in complex stones with high Guy's stone score to ensure complete stone clearance, and also the use of proper medical treatment for residual stones helped to increase the stone clearance rate from 54.8% at 1 month postoperatively to 61.9% at 3 months postoperatively.

For all 42 patients, our complications rate was 54.8% (23 patients). We encountered 30 complications as follows: intraoperative bleeding, four (13.3%) cases; intraoperative pelvicalyceal system perforation or injury, two (6.7%) cases; postoperative fever (whether low or high grade), 13 (43.3%) cases; postoperative gross hematuria, seven (23.4%) cases; and postoperative urine leakage, four (13.3%) cases. So, the most encountered complication in our study was postoperative fever, which may be attributable to increased incidence of preoperative urinary tract infection. For CKD patient group, our complications rate, including both intraoperative and postoperative complications, was 57.1% (12 patients), which was higher than that reported in previous studies [13,17].

An explanation for high rate of complications in our study is recording of both intraoperative and postoperative complications for the assessment of complication rate, whereas most of the previous studies assessed their complication rate by recording the postoperative complications only. Most of our postoperative complications [88.2% (15/17 patients)] were managed conservatively, where only two (11.8%) patients needed operative interventions; in addition, we did not have any mortalities in our study.

In our study, blood transfusion rate was 47.6% (10/21 patients with CKD), which is considered higher than that reported in other studies [7,11–13,17]. Complications rate reported by Bilen *et al*. [13] was 35.6% (66/185 patients), where the most encountered complication was blood transfusion in 36 patients. They also reported three cases of sepsis and two mortalities owing to sepsis.

Patel *et al*. [17] reported the rate of complications of 33.3% in 20 patients. The most common complication was hemorrhage (26.6%) treated by blood transfusion. Urosepsis (grade 4b) occurred in three patients (5%) and was treated with broad-spectrum antibiotics, intravenous fluid, and vasopressors. They did not report any mortality.

Regarding change in serum creatinine and eGFR of patients with CKD in our study, we found a significant deterioration in renal function at early postoperative follow-up, whereas there was an insignificant improvement of renal function at three months postoperatively. This was partially in agreement with overall improvement in renal function reported in previous studies [7,14,15,17].

Limitations

However, our study has imitations. We included only 42 patients who were followed up for 3 months only. Our study was a single-arm study, where more insight could be achieved on the outcome of PCNL in patients with CKD or UPFK with randomization and by recruiting

patients with normal global renal function or normal unilateral GFR as control group. Another limitation was the absence of metabolic profile of the included patients. It had been suggested that preoperative medical treatment to improve metabolic profile enhances the success of PCNL and decreases rate of recurrence [18].

Conclusion

PCNL has favorable outcomes in patients with CKD and patients with UPFK regarding complete stone clearance rates. Safety of PCNL and postoperative renal function improvement remain questionable for further studies.

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Conflicts of interest

There are no conflicts of interest.

References

1. Kartha G, Calle JC, Marchini GS, Monga M. Impact of stone disease: chronic kidney disease and quality of life. Urol Clin North Am 2013; 40:135–147.
2. Rule AD, Bergstralh EJ, Melton LJ, Li X, Weaver AL, Lieske JC. Kidney stones and the risk for chronic kidney disease. Clin J Am Soc Nephrol 2009; 4:804–811.
3. Agrawal MS, Aron M, Asopa HS. Endourological renal salvage in patients with calculus nephropathy and advanced uraemia. BJU Int 1999; 84:252–256.
4. 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.
5. Rudnick DM, Stoller ML. Complications of percutaneous nephrostolithotomy. Can J Urol 1999; 6:872–875.
6. Michel MS, Trojan L, Rassweiler JJ. Complications in percutaneous nephrolithotomy. Eur Urol 2007; 51:899–906.
7. Jones P, Aboumarzouk OM, Zelhof B, Mokete M, Rai BP, Somani BK. Percutaneous nephrolithotomy in patients with chronic kidney disease: efficacy and safety. Urology 2017; 108:1–6.
8. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004; 240:205–213.
9. Cockcroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. Nephron 1976; 16:31–41.
10. Rostoker G, Andrivet P, Pham I, Griuncelli M, Adnot S. A modified Cockcroft-Gault formula taking into account the body surface area gives a more accurate estimation of the glomerular filtration rate. J Nephrol 2007; 20:576–585.
11. Akman T, Binbay M, Aslan R, Yuruk E, Ozgor F, Tekinarslan E, *et al*. Long-term outcomes of percutaneous nephrolithotomy in 177 patients with chronic kidney disease: a single center experience. J Urol 2012; 187:173–177.
12. Ozden E, Mercimek MN, Bostanci Y, Yakupoglu YK, Sirtbas A, Sarikaya S. Long-term outcomes of percutaneous nephrolithotomy in patients with chronic kidney disease: a single-center experience. Urology 2012; 79:990–994.
13. Bilen CY, Inci K, Kocak B, Tan B, Sarikaya S, Sahin A. Impact of percutaneous nephrolithotomy on estimated glomerular filtration rate in patients with chronic kidney disease. J Endourol 2008; 22:895–900.
14. Sairam K, Scoffone CM, Alken P, Turna B, Sodha HS, Rioja J, *et al*. Percutaneous nephrolithotomy and chronic kidney disease: results from the CROES PCNL Global Study. J Urol 2012; 188:1195–1200.
15. Akdeniz E, Bolat M, Sahinkaya N. Treatment of renal stones with percutaneous nephrolithotomy improves renal functions in chronic kidney disease patients. Int J Surg Med 2015; 1:1.
16. Kurien A, Baishya R, Mishra S, Ganpule A, Muthu V, Sabnis R, *et al*. The impact of percutaneous nephrolithotomy in patients with chronic kidney disease. J Endourol 2009; 23:1403–1407.
17. Patel R, Agarwal S, Sankhwar SN, Goel A, Singh BP, Kumar M. A prospective study assessing feasibility of performing percutaneous nephrolithotomy in chronic kidney disease patients-what factors affect the outcome? Int Braz J Urol 2019; 45:765–774.
18. Zilberman DE, Preminger GM. Long-term results of percutaneous nephrolithotomy: does prophylactic medical stone management make a difference? J Endourol 2009; 23:1773–1776.