



Evaluation of Renal Function Following Percutaneous Nephrolithotomy in Patients with Previously Operated Renal Calculi

Md Abdul Baten Joarder¹, Md. Faisal Islam², Anup Roy Chowdhury³, Md Asaduzzaman Rajib⁴,
Mohammad Habibur Rahman⁵, Md Safiul Alam Babul⁶

Abstract

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Objective: Percutaneous nephrolithotomy (PCNL) is a safe and effective treatment modality for patients with renal stones, regardless of the history of previous surgery. For patients who have been previously treated for renal stones, half of them will face stone recurrence within 5-7 years. The objective is to evaluate the renal functional status following percutaneous nephrolithotomy in patients with previously operated renal calculi.

Materials and Methods: From July 2018 to June 2020, previously operated total 44 selected recurrent renal calculi patients underwent standard PCNL. Serum creatinine and renal 99mTc-DTPA scan were done pre-surgery and at post-operative 3 month and year 01, respectively. An assessment was done on renal function, comparing pre and post-operative values. Institutional ethical committee clearance was taken before the commencement of the study.

Results: Among 44 patients, 29 patients (65.9%) had a previous history of open stone surgery, and 15 patients (34.09%) underwent PCNL previously. Mean pre and post-operative serum creatinine were not significant between the cohorts ($p=0.28$). Mean pre-operative split renal functions (in 99mTc-DTPA) of patients ($45.13\pm 14.14\%$) were found almost stable in comparison to mean post-operative value ($44.38\pm 10.96\%$) and ($46.99\pm 9.66\%$) in 03 and 12-month follow-up respectively. Mean GFR for pre-operative and post-operative values were 42.23 ± 6.03 mL/min, 45.93 ± 5.47 mL/min, and 48.99 ± 5.87 mL/min, respectively, which were not statistically significant. Based on serum creatinine and DTPA nuclear renogram, patients showed stability or improvement in renal function at post-operative follow-up. Summarily, a normal pre-operative serum creatinine, regardless of history of previous surgery, maintained stability rather than deterioration in renal function.

Keywords: Percutaneous nephrolithotomy; Recurrent renal calculi; 99mTc-labeled diethylenetriamine pentaacetic acid (99mTc-DTPA).

Conclusions: PCNL is an effective treatment modality in patients with previously operated renal calculi as parameters of renal function had remained stable or slightly improved in the majority of patients on post-operative follow-up.

1. Indoor Medical Officer, Department of Urology, Dhaka Medical College Hospital, Dhaka.
2. Associate Professor, Department of Urology, NIKDU, Sher-E-Bangla Nagar, Dhaka.
3. Assistant Registrar, Department of Urology, NIKDU, Sher-E-Bangla Nagar, Dhaka.
4. Assistant Registrar, Department of Urology, NIKDU, Sher-E-Bangla Nagar, Dhaka.
5. Junior Consultant, Department of Urology, Mugda Medical College Hospital, Hazi Kadam Ali Road, Dhaka.
6. Assistant Professor & RS, Department of Urology, NIKDU, Sher-E-Bangla Nagar, Dhaka.

Correspondence: Dr Md Abdul Baten Joarder, Indoor Medical Officer, Department of Urology, Dhaka Medical College Hospital, Dhaka, Email: abjrossy@gmail.com

Introduction

Urolithiasis is one of the important causes of morbidity affecting the urinary system, like the kidney, with a lifetime prevalence is 13% and 7% in males & females, respectively¹. Although kidney stone disease is not often a fatal disorder, it has a repetitive nature, so it disrupts the quality of life and causes high costs to the health system². Despite appropriate surgical approach and medical prophylactic program, half of patients who have previously been treated for renal stones will face stone recurrence within 5–7 years³. Thus, the number of patients who need a second surgical intervention increases⁴.

The principle of management of urinary stones includes the management of acute symptoms and removal of the stones by non-invasive methods or minimally invasive or endoscopic and rarely by open method and prevention of recurrence. Minimal invasive procedures such as retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PCNL) have been reported as feasible and safe options for various kidney stones⁵. Recently, PCNL has almost completely replaced open surgical procedures. However, in Bangladesh, still many surgeons are practicing open stone surgery in different centers where facilities and expertise for PCNL are not available⁶.

In the setting of recurrent stones, further intervention for stone eradication potentially increases the risk of renal injury. Regardless history of previous surgery, numerous studies have found no deleterious effects of PCNL on renal function in a variety of patient populations⁷. Access to the collecting system and removal of the stone are the main parts of the PCNL. Previous stone surgery may pose challenges for subsequent PCNL, such as prolonged operative time, higher complication rate, and lower success rate because of retroperitoneal scar and the distorted anatomy of the pelvicalyceal system⁸.

Renal function was generally assessed with lab-based parameters such as estimated glomerular filtration rate (eGFR) or serum creatinine. While these data are readily available, their efficacy can be greatly impacted by patient factors, including body mass index (BMI), baseline renal function, and ethnicity⁹. Furthermore, the eGFR serves as an estimate of global nephron function, and in the setting of unilateral kidney manipulation such as PCNL, only a single renal unit is affected. Therefore, eGFR may not accurately reflect

an underlying alteration in kidney function. Nuclear renography using the radioisotope technetium-99m-diethylene triamine pentaacetate (99mTc-DTPA) is commonly used to assess obstruction as well as the relative percent function of each renal unit. It is this latter property that makes DTPA renography uniquely suited to assess perioperative renal function in PCNL, whereby the kidney undergoing manipulation can be individually studied⁹.

Therefore, the purpose of the study was to evaluate the effect of percutaneous nephrolithotomy on perioperative kidney function as determined by technetium-99m-diethylene triamine pentaacetate at post-operative follow-up in previously operated renal calculi patients.

Materials and Methods

A total of 44 patients were diagnosed with recurrent renal stones between July 2018 and June 2020. This was a prospective study. This study was conducted in the urology department of NIKDU, Dhaka. Purposive sampling was done in all admitted cases having recurrent renal stones. The inclusion criteria for standard PCNL were recurrent renal stone patients with a history of previous open stone surgery or PCNL without having significant co-morbidities. On the other hand, renal calculi patients previously treated with ESWL and patients with congenital renal anomalies having significant co-morbidities were excluded from the study. Ethical clearance was taken from the hospital's ethical committee prior to the study. Standard PCNLs were performed on 44 recurrent renal calculi patients. The surgery was performed under general anesthesia. With the patient in the lithotomy position, the 6-Fr ureteric catheter was inserted retrogradely. Following the placement of a 16-Fr Foley catheter, the patient was turned to a prone position, the kidney was punctured under fluoroscopic guidance, and the percutaneous tract was dilated. Then, the tract was secured by the placement of a 28-Fr Amplatz sheath, and the surgery was performed with a 26-Fr rigid nephroscope (Karl Storz). The stone was fragmented with the use of pneumatic lithoclast and by Laser or both. After completion of the procedure, a nephrostomy tube was placed in cases of standard PCNL and removed on the first post-operative day. The patient was discharged from the hospital on 3rd post-operative day.

Comparisons were made between pre and post-operative clinical values, such as changes in serum

creatinine levels and renal ^{99m}Tc -DTPA scan. An assessment was done on renal function comparing pre-surgery and post-operative 03 months and year 01, respectively. Statistical analyses were conducted by using SPSS Version 22, and One Way ANOVA was used as appropriate. P-values of less than 0.05 were considered significant.

Results

A total of 44 patients underwent standard PCNL for recurrent renal stones. 29 patients have had a history of open renal stone surgery, and 15 previously underwent PCNL. Mean patient age, gender distribution, and body mass index (Table 1) were considered independent variables. The pre-operative serum creatinine range between 0.72 and 1.7, and post-operative serum creatinine implies PCNL had favorable outcomes on renal function, but there was no statistically significant difference. There was a slight deterioration in immediate post-operative split function about serum creatinine change. However, at the 12-month follow-up, it recovered (Table 2). Improvements in GFR by eradicating obstruction were assessed.

Table I: Characteristics of patients

Characteristic	mean \pm SD
Mean age in years	53.63 \pm 11.35
Gender	
Male	32
Female	12
Mean Body mass index (kg/m ²)	26.3 \pm 4.7

Values are presented as mean \pm SD

Table II: Postoperative outcomes

Characteristic	Preoperative	Postoperative		p-value
		03 month	12 month	
Mean Change of creatinine (mg/dl) (Mean \pm S.D)	1.17 \pm 0.07	1.21 \pm 0.03	1.24 \pm 0.05	0.28
Mean Change of split renal function (%) (Mean \pm S.D)	45.13 \pm 14.14	44.38 \pm 10.96	46.99 \pm 9.66	<0.001
Mean Change of GFR (ml/min) (Mean \pm S.D)	42.23 \pm 6.03	45.93 \pm 5.47	48.99 \pm 5.87	0.57

Values are presented as mean \pm SD.

Discussion

Percutaneous nephrolithotomy is the preferred treatment for patients harboring recurrent renal stones. Several studies have found no deleterious effects of PCNL on renal function in multiple patient populations, including patients with solitary kidneys, adult polycystic kidney disease, as well as those undergoing multiple procedures. Nuclear renography provides a much more accurate assessment of individual renal function and can also ascertain the presence of obstruction. Several nuclear markers are commonly utilized, including ^{99m}Tc -labeled diethylene triamine penta acetic acid (^{99m}Tc -DTPA) and mercaptoacetyl triglycine (^{99m}Tc -MAG3) to assess renal function¹⁰. The ^{99m}Tc -MAG3 is considered the superior marker as it is well extracted by the kidney, subsequently secreted by the proximal tubules, and rapidly cleared¹¹.

This study represents the analysis of perioperative renal function after percutaneous nephrolithotomy in recurrent renal calculi patients using ^{99m}Tc -DTPA renography. A total of 44 recurrent renal calculi patients who fulfilled the inclusion criteria were selected. Among them, 29 patients (65.9%) had a previous history of open renal stone surgery, and 15 patients (34.09%) had a recurrence following PCNL.

The majority of recurrent renal stones were found between 51-60 years. The mean \pm SD age was 53.6 \pm 11.35. Age categories were almost similar to another study.

Regarding sex distribution, males were predominant (72%). The male-to-female ratio was 2.67:1.

Here, the mean \pm SD BMI was 26.3 \pm 4.7. The result indicates that increased body weight is strongly

associated with renal stone recurrence. Studies evaluated and anticipated that other pre-existing medical conditions, such as obesity and diabetes, will further increase an individual's risk of developing nephrolithiasis⁴.

The mean pre-operative serum creatinine level was almost stable compared to the mean pre-operative 03 and 12-month follow-up value (1.17 ± 0.07 mg/dl vs. 1.21 ± 0.03 mg/dl vs 1.24 ± 0.05 mg/dl). Serum creatinine was not significant between the cohorts ($p=0.28$). Cleveland Clinic group retrospectively reviewed 20 patients with previous PCNL versus 20 patients with previous open surgery. It demonstrated that patients whose serum creatinine was over 1.4 mg/dL had a significant rise in post-operative serum creatinine. Furthermore, the study noted no change in serum creatinine or eGFR in patients with normal pre-operative creatinine (<1.4 mg/dL), regardless of previous surgical history.

In assessing the DTPA renogram data, the median time to post-operative renogram was 3 months and 12 months. The mean post-operative split renal function (in ^{99m}Tc-DTPA) of patients ($44.38 \pm 10.96\%$) in 03 months and ($46.99 \pm 9.66\%$) in 12 months were found to be almost similar to the mean pre-operative value ($45.13 \pm 14.14\%$). This relationship was statistically significant ($p < 0.001$). These data were similar to another study comparing PCNL with open surgery by randomizing 79 patients with complete staghorn calculi. Nevertheless, renal function improved or remained stable in 91% of patients¹².

Comparison between pre and post-operative GFR was not significant in this study (increased post-operatively, $p=0.57$). The mean post-operative 03 and 12-month GFR were higher than the mean pre-operative GFR (45.93 ± 5.47 ml/min vs. 48.99 ± 5.87 ml/min vs. 42.23 ± 6.03 ml/min). Although our results differ from others, we used a different method (^{99m}Tc-DTPA renography) to ascertain better compliance with PCNL than they did¹³. There was a trend towards worsening renal function with an increasing number of PCNL accesses which was not assessed in this study⁹. He also added the decrease in renal function was independent of multiple co-morbidities commonly associated with nephrolithiasis, including diabetes mellitus (DM), hypertension, and chronic kidney disease (CKD). There was also no association with pyelonephritis, a known complication of PCNL.

Studies assessed renal functional changes by ^{99m}Tc-DTPA following RIRS and mini-PCNL and concluded that both had similar effects and favorable outcomes on renal function during a 1-year follow-up period¹⁴. Two other studies have utilized MAG3 renography to assess renal function post-PCNL. Another studied 19 patients with MAG3 renography after PCNL¹⁵. At a median of 22 days after surgery, three patients (16%) had a decrease in renal function, 37% had an improvement, and the remainder had no significant alteration.

This study adds significantly to this literature as this had the same cohort of patients compared to the above studies. Also, it allowed us to demonstrate that irrespective of previous surgery, PCNL used to remove recurrent stones can improve renal function by eradicating obstruction; however, this procedure may affect the functions of the targeted kidney.

Lastly, whether certain co-morbidities and multi-access PCNL associated with alteration in renal function were not evaluated here; therefore, it may over or underestimate the true prevalence and incidences of those situations.

Conclusions

The results of the present study showed that PCNL is an effective treatment modality in patients with previously operated renal calculi as parameters of renal function had remained stable or slightly improved in the majority of patients on post-operative follow-up.

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