

Comparison of Renal Functional Status after Percutaneous Nephrolithotomy with Single and Multiple Tract Accesses

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Abstract:

Background: Percutaneous nephrolithotomy is the preferred treatment for patients with large complex stones. More than one percutaneous access may be required for stone clearance, potentially increasing the risk of renal injury. **Objective:** This study is aimed to compare the renal functional status after percutaneous nephrolithotomy (PCNL) with single and multiple tract accesses. **Methodology:** This prospective quasi experimental study was conducted in the Department of Urology, Sir Salimullah Medical College Mitford Hospital, Dhaka during the period of January 2019 to December 2020. Total 42 renal calculi patients were included by a predefined inclusion and exclusion criteria and allocated into two groups with equal distribution. Patients of Group-A and Group-B underwent single tract PCNL and multiple tract PCNL respectively. **Results:** On the 2nd post-operative day,

both Group A and Group B showed a significant rise in serum creatinine and a decline in eGFR compared to preoperative values ($p < 0.05$), though inter-group differences were not significant ($p > 0.05$). By the third post-operative month, serum creatinine and eGFR values returned to baseline in both groups, with no significant intra- or inter-group differences ($p > 0.05$). DTPA renogram with GFR of the affected kidney at the third month also showed no significant changes from preoperative values or between groups ($p > 0.05$). **Conclusion:** Based on the study findings inference can be drawn that there is no significant renal functional changes are observed after percutaneous nephrolithotomy between single or multiple access tracts.

Key words: Percutaneous nephrolithotomy (PCNL), Diethylene triamine penta-acetic acid (DTPA)

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Introduction:

Kidney stone disease exists among mankind since the earliest record of civilization. Hippocrates described renal stone as first disease of the kidney. Now it is the third most common disease of the urinary tract, after urinary tract infections and pathologic conditions of the prostate¹. Renal stone may cause renal damage by obstruction, infection and surgical interventions². So early and appropriate treatment may be necessary to protect renal function and to avoid complication. Now-a-days, minimally invasive treatment modalities are available for the treatment of kidney stone such as ESWL (Extra corporeal shock wave lithotripsy), PCNL (Percutaneous nephrolithotomy), RIRS (Retrograde intrarenal surgery) and laparoscopic stone surgery³.

PCNL remains as the gold standard treatment for complex kidney stones, providing reasonable stone free rates while preserving renal function⁴. PCNL also enjoys the advantage of shorter length of hospital stay, shorter operating time and time to return to work faster than open surgery⁵. Renal function impairment is a major concern following PCNL, especially in the treatment of large renal calculi. Localized trauma and acute ischemia to kidney tissue are hallmarks of the PCNL access procedure. The most undesirable effects

of nephrolithotomy are renal parenchymal damage, scarring, hypertension and aggravation of renal failure⁶. More parenchymal and microvascular damage occurs during one stage tract dilatation than during gradual dilatation⁷. Single tract PCNL leads to an acute decline in renal filtration and perfusion. The reduction in renal function is generally transient with full recovery observed within several weeks for most patients⁸. On the other hand, creation of multiple percutaneous tracts has the potential risk of bleeding and higher complication rates compared with procedures using single tracts⁹. In the setting of complex or multiple stones, more than one percutaneous access may be required for stone eradication, potentially increasing the risk of renal injury. Numerous studies have found no deleterious effects of PCNL on renal function in a variety of patient populations, including multiple-access procedures¹⁰.

Renal function is 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 ethnicity¹¹. 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 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 studied¹². Therefore, the purpose of the study is to better understand the impact of single versus multiple access PCNL on individual renal function.

Methods:

This hospital based prospective study was conducted in the Department of Urology, Sir Salimullah Medical College Mitford Hospital, Dhaka from January 2019 to December 2020 to evaluate renal functional status after Percutaneous nephrolithotomy with single and multiple tract accesses. Total 42 patients of renal calculi were selected with inclusion and exclusion criteria. All patients were evaluated by history, clinical examination and investigations like CBC, Urine R/M/E & culture sensitivity, X-ray chest P/A view, serum creatinine, ECG, ECHO, RBS, USG of KUB,

IVU and DTPA renogram. Before operation, each patient was evaluated and compared for age and sex of patients, stone size, number, location and pelvicalyceal dilatation. Patients without staghorn calculi were allocated primarily in Group-A and patients with complete or incomplete staghorn calculi were allocated in Group - B for PCNL. If the stone burden could not effectively removed via one tract then additional tracts were obtained at the surgeon's discretion.

All patients were counseled and requested to attend for follow up at OPD clinic. Serum creatinine and Glomerular filtration rate (GFR) was measured preoperatively, on 3rd post-operative day and in 3rd month. To assess selective renal function DTPA renogram was done before operation and at three months after surgery.

Results:

In this study out of 42 patients, majority of the renal stones were found in the age range 31-40 years (52.3% in Group-A and 42.9% in Group-B). Majority of the patients in both the groups (71.4% in Group-A and 61.9% in Group-B) were male and the rest (28.6% in Group-A and 38.1% in Group-B) were female. In this study significant increase in serum creatinine level is observed in both single tract and multiple tract accesses in 2nd POD from the preoperative level. There is no significant increase in serum creatinine level in both single tract and multiple tract accesses after 3 months of operation. Significant decrease in eGFR values are observed in both single tract and multiple tract accesses in 2nd POD from the preoperative level. There is no significant difference in eGFR values in both single tract and multiple tract accesses after 3 months of operation. No significant difference in DTPA renogram with GFR of the affected kidney is observed before and 3 months after operation.

Table-I: Distribution of the patients according to age (n=42)

Age (in years)	Group	
	Group-A (Single tract PCNL) n=21(%)	Group-B (Multiple tract PCNL) n=21(%)
20 –30	02(9.50)	03(14.30)
31 –40	11(52.30)	09(42.90)
41 –50	05(23.80)	07(33.30)
51 –60	03(14.30)	02(9.50)
Mean±SD	40.19±8.80	39.48 ±8.77
AgeRange	27–60	24–55

Table-II: Distribution of the patients according to gender (n=42)

Gender	Group	
	Group -A Single tract PCNL n=21(%)	Group -B (Multiple tract PCNL) n=21(%)
Male	15(71.40)	13(61.90)
Female	06(28.60)	8(38.10)
Total	21 (100.0)	21 (100.0)

Table-III: Comparison of the serum creatinine levels before and 2 days after operation (n=42)

Group	Mean Serum creatinine level (±SD) (mg/dl)		P value
	Preoperative	On 2 nd post operative day	
Group -A (Single tract PCNL)	0.89(±0.057)	1.00(±0.068)	*0.0001
Group -B (Multiple tract PCNL)	0.94(±0.102)	1.044(±0.114)	*0.0001

*: Significant P value < 0.05 Not Significant P value>0.05
Results were expressed as mean±SD Data were analyzed by Student's t test

Table-IV: Comparison of the serum creatinine levels before and 3 months after operation (n=42)

Group	Mean Serum creatinine level (±SD) (mg/dl)		P value
	Preoperative	After 3 months of operation	
Group -A (Single tract PCNL)	0.89(±0.057)	0.87 (±0.534)	0.335
Group -B (Multiple tract PCNL)	0.94(±0.102)	0.95(± 0.106)	0.230

*: Significant P value < 0.05 Not significant, P value>0.05.
Results were expressed as mean±SD Data were analyzed by Student's t test

Table-V: Comparison of the eGFR values before and 2 days after operation (n=42)

Group	Meane GFR values (±SD) (ml/min/1.73m ²)		p value
	Preoperative	On 2 nd post - operative day	
Group -A (Single tract PCNL)	90.26 (±14.10)	69.326(±9.89)	*0.0001
Group -B (Multiple tract PCNL)	88.55 (±7.99)	66.85 (±4.53)	*0.0001

*Significant P value < 0.05 Not Significant P value > 0.05
Results were expressed as mean±SD Data were analyzed by Student's t test

Table-VI: Comparison of the eGFR values before and 3 months after operation (n=42)

Group	Meane GFR values (±SD) (ml/min/1.73m ²)		p value
	Preoperative	After three months of operation	
Group -A (Single tract PCNL)	90.26(±14.10)	90.36(±14.76)	0.794
Group -B (Multiple tract PCNL)	88.55(±7.99)	88.60 (±8.33)	0.910

*Significant P value < 0.05 Not Significant P value > 0.05
Results were expressed as mean±SD Data were analyzed by Student's t test

Table-VII: Comparison of the DTPA renogram with GFR of the affected kidney before and 3 months after operation (n=42)

Group	Mean DTP Arenogram with GFR values (±SD) (ml/min)		p value
	Preoperative	After three months of operation	
Group -A (Single tract PCNL)	46.33(±7.722)	47.10(± 8.061)	0.084
Group -B (Multiple tract PCNL)	45.14(±4.138)	45.96(± 4.341)	0.087

Not Significant P value > 0.05

Results were expressed as mean±SD Data were analyzed by Student's t test

Discussion:

This prospective study was designed to compare the renal functional status after percutaneous nephrolithotomy with single and multiple tract accesses. A total of 42 patients who were managed with single tract PCNL were labelled as Group A and patients requiring multi-tract PCNL were labelled as Group B. All procedures were done by single or multiple subcostal or supracostal puncture on the basis of assessment of calculus configuration and collecting system anatomy. When stone was not possible to clear with single tract access then multiple tract was performed. Single tracts were established in twenty one cases, two tracts were established in nineteen patients, three tracts in two patients. In this study, mean age was 40.19 ±8.80 years in single tract access and 39.48 ±8.77 years in multiple tract accesses.

The age range of the present study was comparable with the study done by Akman et al. (2010) where 43.5 ± 14.4 years and 40.8 ± 14.0 years in single and multiple tracts respectively¹³. Singla et al. (2008) observed average age was 39.8 years for the patient with multiple tract PCNL in their study¹⁴. In the present study male patients were predominant in both the groups. In the studies of Akman et al. (2010) and Hossain et al. (2016) observed similar result where male was predominant^{13,15}. The result was consistent with the epidemiology of renal stone because in women there was protective effect of oestrogen which caused enhanced renal calcium absorption and reduced bone resorption. Thereby decreased the chance of stone formation in female. In this study, significant difference in mean serum creatinine level in 2nd POD of both groups were found higher than the preoperative value ($p < 0.05$). The difference in serum creatinine level between the two groups was not statistically significant ($p > 0.05$).

In the studies Akman et al. (2010) and Hegarty and Desai (2006) observed similar result where mean serum creatinine level in both groups increased at early postoperative period^{13,16}. The result was consistent with the study of Handa et al. (2009) where single tract PCNL and multiple tract PCNL revealed a rise in serum creatinine that remained elevated 48 hours after surgery¹⁷. In the present study no significant difference was observed in mean serum creatinine level in 3rd postoperative month of both groups than the preoperative value ($p > 0.05$). The difference in serum creatinine level between the two groups was not statistically significant ($p > 0.05$). Similar result was observed in the study of Canes et al. (2009)¹⁸. They reported an increased mean early postoperative serum creatinine level dropped to preoperative levels at 1 month and 1 year after surgery. In this study, significant difference in mean eGFR value in 2nd POD of both groups were found lower than the preoperative value ($p < 0.05$). The difference in eGFR values between the two groups was not statistically significant ($p > 0.05$). In a study Nouralizadeh et al. (2010) observed similar result where the first 2 days after PCNL, GFR decreased from 87.5 ± 32.2 mL/min to 75.9 ± 25.0 mL/min but on the 3rd day, it raised to 81.9 ± 26.4 mL/min¹⁹. Handa et al. (2009) in their retrospective analysis performed on patients who underwent single tract PCNL and multiple tract PCNL revealed significant decrease in estimated glomerular function after operation which was independent of the number of access sites¹⁷. These findings were consistent with present study.

In the present study no significant difference was observed in mean eGFR value in 3rd postoperative month of both groups than the preoperative value ($p > 0.05$). The difference in eGFR values between the two groups was not statistically significant ($p > 0.05$). In a study Nouralizadeh et al. (2010) observed similar result which was consistent with present study¹⁹. Reynolds et al. (2018) performed retrospective study that showed the impact of PCNL on renal function²⁰. Studies showed that patients with normal eGFR will drop their renal function significantly after the procedure but recover to the baseline function at about 6 months period after the procedure. This recovery time can be prolonged due to renal functional abnormalities, multiple tracts during the procedure, multiple staged procedures and finally, postoperative complications such as bleeding and sepsis. In this study, no significant difference was observed in mean DTPA renogram with GFR on affected kidney in 3rd postoperative month of both groups than the preoperative value ($p > 0.05$). The difference in DTPA renogram with GFR between the two groups was not statistically significant ($p > 0.05$).

The result was consistent with the study of Fayad et al. (2014) and Mayo et al. (1985) where they investigated renal functions with radionuclide studies and found improved renal function 2 to 3 months after PCNL^{21,22}. Although our results differ with those of Gorbachinsky et al. (2016) where they demonstrated that patients with multi-access percutaneous access have a statistically significant decrease in ipsilateral renal function of approximately 2.3%, a difference not observed with single access procedures¹². Interestingly, the decrease in renal function was independent of multiple comorbidities including diabetes mellitus (DM), hypertension, chronic kidney disease (CKD), gout, and parathyroid disorders.

In this present study, there was transient increase in serum creatinine and eGFR value in the very early postoperative period in both groups of single and multiple access tracts but after a while it recovers. DTPA renogram also revealed no significant changes in renal function in both groups after percutaneous renal stone surgery. Therefore, the results of the present study concur with prior literature stating that the impact of PCNL using single or multiple access tracts on renal function is similar.

Conclusion:

Comparing the findings of the present study, it can be concluded that there is a transient loss of kidney functions in the very early days after surgery in both

groups of single and multiple access tracts. But after a while it recovered. So, there is no significant renal functional changes observed after percutaneous nephrolithotomy between single or multiple access tracts.

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