

Safety and Outcome of Percutaneous Nephrolithotomy (PCNL) In Normal Vs Impaired Renal Function: A Tertiary Care Centre Experience

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Abstract:

Background: Aim of this study to compare the short-term clinical outcome of Percutaneous nephrolithotomy (PCNL) in patients with normal renal function (NRF) and impaired renal function (IRF) and to evaluate the effects of PCNL on renal function in patients with impaired renal function.

Material & Method: Records of 140 consecutive patients who underwent PCNL from January 2014 to December 2018 were retrospectively reviewed. 100 patients had estimated glomerular filtration rate (eGFR) >60ml/min/1.73m² (NRF Group) and 40 patients had eGFR <60ml/min/1.73m² (IRF Group). Surgical parameters, short-term clinical outcome and adjuvant treatment rates were compared between these two groups.

Result: There were no statistically significant differences ($p>0.05$) between these two groups for complications ($p=0.527$) and the need for ancillary procedures ($p=0.705$). The mean postoperative difference in hemoglobin and hematocrit from preoperative value is 1.3 and 1.9 and 3.34 and 4.29 with a p-value of 0.006 and 0.049 in the NRF group and IRF group respectively. The mean nephrostomy tube duration was 4.98 days in the NRF group and 5.95 days in the IRF group and is statistically significant ($p=0.011$). The mean hospitalization duration was 5.2 days in the NRF group and 6.15 days in the IRF group ($p=0.032$). There is a significant improvement in the eGFR in both groups, Group 1 with 3 ml/min/1.73m² ($p=0.002$) and group 2 with 10 ml/min/1.73m² ($p=0.001$).

Conclusion: We achieved similar stone clearance and complication rates with PCNL in both groups. Overall, surgery will not be causing further damage to the renal function in patients with impaired renal function after treatment.

Keywords: Renal stone, percutaneous nephrolithotomy, Glomerular filtration rate, Renal Function

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I. Introduction

The prevalence of urolithiasis is 4%-8% in North America and Europe and similar findings were noted in Japan. In local studies, the prevalence seems to be lower. In 1979, the incidence of urinary calculi in Malaysia was estimated at 34.9 per 100,000 populations. In Kelantan, it ranges from 9.8-37 per 100 000 population. Patients with renal impairment comprise 0.78-17.5% of the cases treated for the urinary stone disease [1-3]. Usually they have various medical conditions such as diabetes, hypertension, anemia, and bleeding disorders, which have a serious effect on their general health. Percutaneous nephrolithotomy (PCNL) procedure is an excellent alternative to open surgery with a more than 90% success rate. There may be concerns that patients with impaired renal functions will suffer from lower success rates and higher complication rates than patients with normal renal function. Thus, compromised renal function may constitute a drawback to standard surgical treatment and cause bias in favor of more conservative measures. Since renal failure is a progressive condition, the presence of stones in the urinary tract may accelerate the course of the disease [4]. Deterioration in the renal functions due to the presence of stones is mainly by causing obstruction and infection. Duration of the stone disease, multiple procedures, and stone recurrence also negatively influence renal function [5]. Therefore, patients with compromised renal function benefit from eliminating calculi from the urinary tract, which may lead to improved renal function and avoidance or postponement of dialysis. On the other hand, there is a concern for the serious effects of surgical and endourological procedures on kidney function and the possibility of increased peri and postoperative complications in patients with kidney failure [6]. Herein, we analyzed the

short-term clinical outcome of Percutaneous nephrolithotomy (PCNL) in patients with normal and impaired renal function and evaluated the effects of PCNL on renal function in patients with impaired renal function.

II. Material and Method

A retrospective cohort study from January 2014 to December 2018 at Urology Unit, Department of Surgery, Hospital Universiti Sains Malaysia, Kelantan. All patients with renal calculi who underwent Percutaneous nephrolithotomy (PCNL) were evaluated. Our Inclusion criteria were patients who had renal calculi and underwent PCNL. Exclusion criteria were Patients under 12 years of age and congenital kidney conditions like horseshoe kidney. All the operations being performed in a single centre by any member of a team of the urologist. Preoperative optimization and nephrology input were obtained for all patients with impaired renal function for the control of medical problems as well as the planning of renal replacement therapy before and after surgery as necessary. The stone diameter was taken as the largest diameter of the stone measured in millimeters on a plain radiogram and divided into simple renal stone, pelvic renal stone, complex staghorn calculi, simple staghorn calculi and multiple renal calculi. A pneumatic and ultrasonic lithotripter were used for stone fragmentation and stone clearance. Hospitalization time was defined as the number of days the patient spent at the hospital starting from the day of surgery. A successful outcome was defined when the patients were rendered stone-free or had residual fragments smaller than 4 mm after PCNL with or without adjuvant treatments. Patients who had residual fragments larger than 4 mm after PCNL with or without adjuvant treatments were regarded as failures. The patients are divided into two groups, NRF Group with normal renal function (NRF) based on eGFR >60ml/min/1.73m² and IRF Group with impaired renal function (IRF) based on eGFR < 60ml/min/1.73m². Surgical parameters, short-term clinical outcome and adjuvant treatment rates will be compared between these two groups including pre and postoperative eGFR were compared in order to assess the effect of PCNL on renal function. Data were obtained from the ward admission records and all necessary information was obtained. All the data entry and analysis were carried out using SPSS version 20.0. A Chi-square test will be applied for categorical variables and an independent t-test will be applied for numerical variables. A p-value of < 0.05 will be considered significant.

III. Result

A total of 152 patients underwent PCNL from January 2014 to December 2018. Only 140 cases were fulfilled the inclusion criteria and included in this study. The other cases were excluded from this study for various reasons such as incomplete data and missing folders. Out of 140 cases, 100 (71%) patients fell into the NRF Group, while the IRF group had 40 (29%) patients (Table 1). There was no significant difference in the age group between the two groups (p=0.891) as the mean age of patients in NRF and IRF were 48±11.3 and 55±12.4 years respectively. 77 (55%) were males and 63(45%) were females involved in this study. There were more males in the impaired renal function group with the NRF Group having 51 (51%) males and 49(49%) females and the IRF group, 26(65%) males and 14(35%) females. 95% of the IRF group patients are Malays and Chinese 5% and the NRF group had 95% Malays, 4% Chinese and 1% Siamese. Out of 140 cases, 72 (51.4%) right kidneys and 68(48.6%) left kidneys were operated on. NRF Group had 53 (53%) right and 47 (47%) left kidneys while group two had 19 (47.5%) right and 21 (52.5%) left kidneys. The type of renal calculi and the presence of hydronephrosis in each group are summarized in Table 1. The majority of renal calculi types in both groups were simple staghorn calculi with 35% and 40% in the NRF and IRF groups. The leading degrees of obstruction in both the groups were mild hydronephrosis with 49% in the NRF group and 45% in the IRF group.

Table 1: Demographic data and clinical characteristic of PCNL patients in the NRF and IRF group

	NRF group (n=100)	IRF group (n=40)	P value
Age	48±11.3	55±12.4	0.891
eGFR (mL/min)			
> 60ml/min/1.73m ²	100(71%)	-	
< 60ml/min/1.73m ²	-	40(29%)	0.651
Ethnicity			
Malay	95(95%)	38 (95%)	
Chinese	4(4%)	2(5%)	
Indian	-	-	
Siamese	1(1%)	-	
Gender			0.321
Male	51 (51%)	26 (65%)	
Female	49 (49%)	14 (35%)	
Type of renal calculi			0.185
Simple staghorn	35 (35%)	16 (40%)	
Complex staghorn	14 (14%)	12 (30%)	
Single renal stone	17 (17%)	2 (5%)	
Multiple renal stones	12(12%)	6 (15%)	
Renal pelvis stone	22 (22%)	4 (10%)	

Stone laterality			0.437
Right	53(53%)	19(47.5%)	
Left	47(47%)	21(52.5%)	
Degree of obstruction /Hydronephrosis			0.541
Mild	49 (49%)	18 (45%)	
Moderate	27 (27%)	14 (35%)	
Severe	4 (4%)	2 (5%)	

PCNL: percutaneous nephrolithotomy, NRF: normal renal function, IRF: Impaired Renal function, GFR: glomerular filtration rate, BUN: Blood, Urea, nitrogen, R: right, L: Left. Data presented as n (%) or mean ± standard deviation.

The common postoperative complications in both groups are summarized in Table 2. 77% in the NRF group and 67.5% in the IRF group had no major complications. More patients in the IRF group needed postoperative blood transfusion 20% compared to patients in the NRF group were 14%. Overall, there is no significant difference ($p=0.527$) in the complications rate between the two groups. Ancillary procedures are sometimes needed to complete the stone management if the stone clearance is not satisfactory. The ancillary procedures were done in both groups are shown in Table 2. The mean postoperative difference in hemoglobin and hematocrit from preoperative value is 1.3 and 1.9 and 3.34 and 4.29 with a p -value of 0.006 and 0.049 in the NRF and IRF groups respectively. Since the p -value of <0.05 is statistically significant, the hemoglobin difference is statistically significant with a very slightly significant hematocrit value. The mean nephrostomy tube duration was 4.98 days in the NRF group and 5.95 days in the IRF group and is statistically significant ($p=0.011$). The mean hospitalization duration was 5.20 days in group 1 and 6.15 days in the NRF group and is statistically significant ($p=0.032$). Overall, there is a significant improvement in eGFR in both groups, Group 1 with 3 ml/min/1.73m² ($p=0.002$) and group 2 with 10 ml/min/1.73m² ($p=0.001$). This shows that PCNL improves renal function, which is more significant in a patient with preoperative impaired renal function.

Table 2: surgical parameter and outcomes of PCNL in NRF and IRF group

	NRF group (n=100)	IRF group (n=40)	P-value
⊖Hb (g/dl)	1.3±0.9	1.9±1.15	0.006
⊖Hematocrit %	3.34±2.3	4.29±2.9	0.049
Nephrostomy time (days)	4.98 ±1.98	5.95±2.07	0.011
Hospitalization (days)	5.20±3.0	6.15±3.1	0.032
eGFR post PCNL (ml/min/1.73m ²)	3	10	0.001
Complication (%)			0.527
Fever	29 (29%)	13 (32.5%)	
Need for Blood transfusion	14 (14%)	8 (20%)	
Chest tube insertion	3 (3%)	1 (2.5%)	
Urinary tract infection	3 (3%)	1 (2.5%)	
Success rate (%)	74(74%%)	24(60%)	0.368
Ancillary procedures (%)			0.705
Secondary PCNL	15 (15%)	10 (35%)	
ESWL	8 (8%)	5 (15%)	
Secondary PCNL + ESWL	3 (3%)	1 (2.5%)	

⊖Hb: decrease in mean blood hemoglobin value after PCNL, ⊖Hematocrit: decrease in mean blood hematocrit value after PCNL. PCNL: percutaneous nephrolithotomy, NRF: normal renal function, IRF: Impaired Renal function GFR: glomerular filtration rate. Data presented as n (%) or mean ± standard deviation.

IV. Discussion

Renal calculi continue to be an important cause of renal impairment. The incidence of renal impairment in patients treated for urinary stone disease shows variations between centers and probably depends on the socioeconomic characteristics and the referral patterns of the region. Renal failure is frequently a progressive condition. The presence of renal calculi may accelerate the course of the disease and deteriorates renal functions mainly by causing obstruction and infection [4,7].

In this study, we compared the surgical outcome between the NRF group and the IRF group. It comprises 140 patients with 100 and 40 patients in the NRF group and IRF group, respectively. No statistically significant in age and sex distribution. The kidney, stone site and degree of obstruction were also similar. Therefore the possible cause of the renal impairment in IRF group patients was obstruction caused by the stone.

Most of the complications were minor, and the complication rate differences were not statistically significant in both groups ($p=0.527$). The postoperative complication rates in both groups were similar to international standards. Blood loss is a common occurrence during PCNL either during or after an operation that sometimes required blood transfusion. After percutaneous procedures, the incidence of blood transfusion has been 2% to 45% among different series [8-10]. In this study the difference in mean blood hemoglobin ($p=0.006$) value and ($p=0.006$) hematocrit after PCNL were statistically significant. Twenty percent needed blood

transfusions in the IRF group compared to 14% in the NRF group. This shows that patients with impaired renal function bleed more than patients with normal renal function. The nephrostomy tube remained significantly longer in the IRF group 5.95 days compared to 4.98 days in the NRF group ($p=0.011$). The hospital stays in the IRF group were also longer, 6.15 days compared to 5.2 days in the NRF group ($p=0.032$). This is probably because IRF group patients needed to manage more carefully in the postoperative period. After PCNL became a viable method of stone-treatment, many studies that were done showed no significant damage to the functional nephrons in the kidneys. This is probably due to improved technique and a good understanding of the Endourology anatomy gained from experience and study models. As PCNL became the treatment of choice for patients with bulky stones, several authors have reported the benefit of this surgery in patients with renal impairment from various retrospective studies [10-12]. Gupta et al. [3] reported that the post PCNL serum creatinine value was lower than the pre treatment value in 32 out of 33 patients. Forty-six of these patients had bilateral upper urinary calculi and the remaining 32 had a solitary functioning kidney. Overall, the serum creatinine levels at the last follow-up showed a significant improvement over those before treatment. Sixty-four patients improved renal function and in 11 patient's renal function remained unchanged or deteriorated during follow-up. [1]

Out of 84 patients who underwent PCNL, overall renal functions improved in 33 patients (39.3%), stabilized in 24 patients (28.6%), and deteriorated in 27 patients (32.2%). The baseline serum creatinine concentration correlated well with the postoperative renal function. Renal function stabilized or improved in nearly all patients with baseline serum creatinine less than 2 mg/dl and deteriorated in all patients with baseline serum creatinine higher than 6 mg/dl. In this group, 15 patients underwent PCNL, 2 ESWL and 3 open surgeries [2]. The mean glomerular filtration rate improved significantly in renal failure patients after stone disease treatment [13]. Many other studies have revealed similar results.

In this study, eGFR improved significantly in almost all 40 patients who had impaired renal function at 6 weeks postoperative period. This goes to show that the primary cause of renal impairment in all these patients is renal calculi. Following PCNL, the function of the operated kidney improved, resulting in a significant increase of total eGFR. The authors concluded that kidney stones play a significant role in developing chronic kidney disease and suggested that the prevention of kidney stones may delay the onset of chronic kidney disease. The approach should be aggressive enough to achieve stone-free kidneys, but each procedure results in some loss of renal function. The stone disease that recurs requires multiple procedures over the years and this is also a contributing factor towards chronic renal insufficiency. Measures should be taken to minimize renal injury and minimally invasive techniques should be used as far as possible [14-17].

It has to be noted that the renal function's evaluation by serum creatinine levels and eGFR has some disadvantages, especially in patients with two functioning kidneys. The contralateral kidney compensates for the deterioration in one kidney. Thus, the change in serum creatinine does not accurately reflect the change in the function of the concerned kidney. Unfortunately, differential renal functions like DTPA and creatinine clearance measurements were not available for all patients. Our results from this study indicate that most patients presenting with urolithiasis and renal impairment experience renal function improvement with early aggressive intervention aimed at complete stone clearance and prevention of urinary infection. However, for long-term follow-ups, serum creatinine only provides valid information on the overall renal function that does not reflect the effect of PCNL on the individual kidney.

V. Conclusion

Outcomes and complication rates are not significantly different in PCNL patients with IRF compared to PCNL patients with NRF. Patients with renal impairment should be treated as patients with normal kidney function. A multidisciplinary team approach and good supportive measures, such as availability of renal replacement therapy, were essential factors in obtaining these favorable results. After PCNL, there was an overall increase in eGFR values at six weeks postoperative period.

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