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ORIGINAL PAPER

Efficacy and outcome of percutaneous nephrolithotomy in patients with calculus nephropathy

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Abstract The aim of this study was to prospectively evaluate the efficacy and outcome of percutaneous nephrolithotomy in patients with nephrolithiasis and chronic renal insufficiency. Between January 2006 and June 2009, 30 patients (20 males and 10 females; mean age 45 years, range 18–65; mean serum creatinine 6.3 ± 1.57 mg%) with calculus nephropathy were treated in our department. In 25 patients with obstructed and infected systems preliminary percutaneous nephrostomy or double J stenting was done. After stabilization and treatment of sepsis, percutaneous nephrolithotomy was done. Eight patients underwent bilateral procedure and 22 underwent unilateral procedure. Twenty-two patients needed a single sitting while eight patients needed two sittings for stone clearance. The renal function was monitored by serial creatinine estimations. Of the 30 patients, 27 patients achieved complete clearance. Renal function was improved in 27 patients. Six patients developed postoperative sepsis. Two patients required angioembolization for uncontrollable bleeding. There was no mortality. Patients with calculus nephropathy can be salvaged using PNL with good improvement in renal function and acceptable morbidity when appropriate preoperative preparation and perioperative care are given.

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Introduction

The prevalence of urinary stone disease is estimated to be 2–3%. Patients with renal insufficiency comprise 1.65–1.9% of the cases treated for urinary stone disease in recent large series [1, 2]. Renal insufficiency in patients with urolithiasis could be either due to calculus nephropathy or nephropathy of medical renal disease or both. Management of stones in chronic renal insufficiency is challenging. There are concerns that these patients may have lower success and higher complication rates compared to patients with normal renal function. An appropriate approach to their management has been shown to stabilize renal function and delay the requirement of renal replacement therapy [3]. We analyzed the results of patients with impaired renal functions purely due to stone disease who underwent percutaneous nephrolithotomy (PNL) for the treatment of renal stone disease and evaluated the surgical parameters, outcome and the effect on serum creatinine value.

Patients and methods

Between January 2006 and June 2009, 30 patients (20 males and 10 females) with renal stone disease presented to our department with calculus nephropathy. All patients with established medical renal disease (e.g. diabetic nephropathy, hypertensive nephropathy, glomerulonephritis, reflux nephropathy, nephritic syndrome) were excluded. Patients were appropriately evaluated and treated using antibiotics

and percutaneous nephrostomy for infected hydronephrosis. The preoperative factors analyzed were age, sex, preoperative urinary tract infection, the serum creatinine level, past intervention for stone disease, stone size and renal parenchymal thickness. The operative factors analyzed were tract number, intraoperative complications and operative time. The postoperative complications, hospitalization time, stone-free status, and recommendation for an ancillary procedure were noted. All procedures were performed under general anesthesia in prone position as a single or staged procedure. Access to the pelvicalyceal system was obtained under fluoroscopic guidance via the posterior calyx from which maximal stone bulk could be cleared with minimal complication. The tracts were dilated using sequential Amplatz dilators. Tracts were usually dilated up to 30F. The number of tracts created depended on the stone bulk, configuration, and pelvicalyceal anatomy. Pneumatic lithotripsy and stone forceps were used for stone clearance. After completion of procedure, 18F nephrostomy tubes were inserted in all patients. Plain X-ray KUB film was taken postoperatively to document residual calculi. Shock wave lithotripsy was used in some patients for complete clearance. Postoperative serum creatinine was serially measured. All data were transferred to SPSS version 15 and statistical significance of associations between different variables was found out. A p value of <0.05 was taken as significant.

Results

Thirty patients with calculus nephropathy were included in the study. The mean serum creatinine on admission was 6.3 ± 1.57 mg%. The mean (range) patient age was 45 (18–65) years. Ten patients had bilateral renal stones, ten had unilateral renal stone with small opposite kidney due to previous stone disease, six patients had solitary functioning kidney with renal stone and four had unilateral renal stone with contralateral ureteric stone. Presenting symptoms included various combinations of flank pain (83.3%), fever (76.6%), oliguria (43.3%), uremic symptoms (20%) and anuria (10%). The mean duration of symptoms (range) was 18 months (2 weeks to 6 years). Eight patients had undergone previous endourologic procedure and six had open surgery. None of the patients had any significant co-morbid condition. The patient, stone, and operative characteristics are presented in Table 1.

A preliminary ultrasound-guided percutaneous nephrostomy (PCN) was performed under local anesthesia to relieve obstruction in 24 patients. Unilateral PCN was done in 13 patients, bilateral PCNs were done in 10 patients, unilateral PCN with contralateral DJ stenting was done in 1

Table 1 Patient, stone, and operative characteristics

Characteristic	
Preoperative	
Patients (n)	30
Mean age (years)	44.8 ± 16.5
Male/Female (n)	20/10
Presenting symptom	
Flank pain	25 (83)
Fever	23 (77)
Oliguria	13 (43)
Uremic symptoms	6 (20)
Anuria	3 (10)
Mean duration of symptoms	18 months (2 weeks to 6 years)
Previous interventions	
Endourologic procedure	8
Open stone surgery	6
Positive first puncture urine culture	8 (26.6)
Positive stone culture	9 (30)
Mean serum creatinine (mg/dl)	
Predrainage	6.3 ± 1.57
Postdrainage	2.9 ± 1.52
Post PNL	2.56 ± 1.46
Prior stone treatment	
Present	14 (47)
Absent	16 (53)
Mean stone size (cm)	
Unilateral	3.8
Bilateral	7.1
Preoperative drainage procedure	
Percutaneous nephrostomy (PCN)	
Unilateral	13 (43)
Bilateral	10 (33)
PCN with contralateral DJ stenting	1 (3.3)
Bilateral DJ stenting	1 (3.3)
Operative	
Mean operative time (min)	110 ± 32
Mean no. of tracts	1.52
Postoperative	
Immediate stone-free rate	27 (90)
Secondary procedure requirement	
SWL	3 (10)
Complications	
Sepsis	6 (20)
Blood transfusion requirement	6 (20)
Angioembolization	2 (6.6)
Pneumothorax	1 (3.3)
Median hospitalization time (days)	10 ± 5.2

Data presented as number of patients, with percentages in parentheses or mean $\pm$ SD, unless otherwise noted

Table 2 Correlation of baseline serum creatinine with postoperative renal function

Group	Serum creatinine (mg/dl)		Renal functional outcome (%)			Total
	Range	Mean ± SD	Improved	Stabilized	Deteriorated	
A	1.5–3	2.04 ± 0.47	16 (76.2)	5 (23.8)	0 (0)	21
B	3–4.5	3.57 ± 0.32	3 (50)	2 (33.3)	1 (16.7)	6
C	>4.5	6.9 ± 0.98	0	1 (33.3)	2 (66.7)	3
Total	–	–	22 (73.3)	5 (16.7)	3 (10)	30

patient and bilateral DJ stenting was done in 1 patient. Stones were subsequently retrieved by dilating the same percutaneous tract after stabilization. The mean stone size for unilateral disease was 3.8 cm and for bilateral disease was 7.1 cm. Of the ten patients with bilateral stones, eight underwent stone retrieval by bilateral PNL while two underwent unilateral PNL and shock wave lithotripsy (SWL) for the other side. The remaining 20 underwent unilateral PNL. Twenty-two patients needed a single sitting while eight patients needed two sittings for stone clearance.

All the 25 patients who underwent PCN or DJ stenting showed improvement in renal function. The mean predrainage creatinine was 6.3 ± 1.57 mg% and the mean nadir creatinine after drainage procedure was 2.87 ± 1.52 mg%. In all these patients the improvement in renal function stabilized over 4–6 weeks. The renal function outcome following PNL is shown in Table 2. After PNL, 22 patients showed further improvement in the renal function. The mean serum creatinine after 6 weeks was 2.56 ± 1.46 mg%. Complete stone clearance was achieved with PNL in 27 (90%) patients. Rest of the three patients underwent SWL for stone clearance.

Of the remaining eight patients, five patients showed stabilization and three patients showed deterioration in renal function during follow up, suggesting irreversible renal damage. The common factors associated with these patients were severe renal failure (serum creatinine > 4.5 mg%), urosepsis at presentation with thick pus drainage during PCN and thinned out parenchyma (≤4 mm) in both the kidneys. Compared to these patients, none of the 22 patients with improvement in renal function had pus during initial PCN and all of them had better renal parenchymal thickness at least in one kidney. None of the patients in this study required renal replacement period during follow up.

Postoperatively two patients had uncontrollable bleeding and needed angioembolization. Mean transfusion requirement in this study was 1.73 units of blood. Mean hemoglobin loss was 3.05 g %. Postoperative sepsis occurred in six patients. Two patients needed postoperative dialysis. Other complications encountered were hyponatremia in one patient, metabolic acidosis in one patient and pneumothorax in another patient. Mean postoperative stay in this cohort was 10 ± 5.2 days.

Postoperatively six patients developed urosepsis. The association between postoperative sepsis and preoperative creatinine value was statistically significant with a chi-square value of 9.76 ($p = 0.008$). Out of eight patients who had infected first puncture urine, six had postoperative sepsis and no patients with sterile culture had sepsis. Of these six patients, three had deterioration in postoperative renal function. Renal stone culture revealed nine patients with infected stones. Of these, four patients had postoperative sepsis.

Stone analysis was available for 27 patients. Ten (37%) patients had struvite stone, ten (37%) had mixed stones (struvite, calcium oxalate dehydrate and monohydrate) and remaining 7 (26%) patients had calcium oxalate mono hydrate stone.

Discussion

The introduction of PCNL has changed the treatment of large and staghorn renal calculi. Stone clearance has been shown to improve renal function and outcome in patients with chronic renal failure due to nephrolithiasis [1–3]. However, there are concerns that these patients will suffer from lower success and higher complication rates compared to patients with normal renal function [3, 4]. There is a relative lack of quantitative knowledge regarding the outcome of PNL in patients with calculus nephropathy.

In this study cohort 25 out of 30 patients underwent preoperative drainage procedures. The preoperative drainage rates were 82% (64 out of 78) in Agarwal et al. [3]. series and 55% (12 out of 22) Yayicioglu et al. [5]. series. Complete stone clearance was achieved in 27 (90%) patients with PNL. The rest were rendered stone-free using adjunctive SWL. The clearance rate achieved in our series was better than other series [6, 7]. The mean hospital stay, deterioration in glomerular filtration rate and major morbidity rates have been shown to be significantly greater in patients with residual calculi than in those with total clearance [7].

In most of our patients there was a significant improvement in renal function after preliminary drainage procedure followed by PNL. We found a significant correlation between preoperative serum creatinine and postoperative

serum creatinine on follow up. In the study by Kukreja et al. [2] also they have noted baseline creatinine value as predictor of postoperative renal function. Our results indicate that most patients presenting with kidney-stone disease and renal insufficiency, experience improvement or stabilization of renal function with early aggressive intervention aimed at complete stone clearance and prevention of urinary infection. Improvement in renal function is greater in mild to moderate renal failure. None of the patients in our study has required renal replacement therapy during follow up. Patients with severe kidney-failure and pus in the collecting system are less likely to show a significant improvement in renal function. However, even these patients will enjoy the benefits of improved quality of life and postponement of replacement therapy if their stones and infection can be cleared [1–3, 7].

There may be concerns regarding the possible harmful effects of percutaneous approach in functionally compromised kidneys. As compared to open stone surgery, patients undergoing percutaneous nephrolithotomy have a shorter hospitalization, operative time and a significantly reduced period of recuperation, allowing earlier return to work and decreased disability [8]. It has been shown that there was no deterioration of renal function following PNL in long term follow-up [9]. In animal studies also it has been proven that there is no functional deterioration following PNL [10, 11]. The outcome of our study also shows that PNL can be done in functionally compromised kidneys with good outcomes.

Many patients with chronic renal insufficiency have anemia of chronic disease, platelet dysfunction, metabolic acidosis, and disturbances in serum electrolytes. Conditions such as diabetes and hypertension are also frequent. Therefore, any surgical intervention in these patients carries high morbidity and mortality rates. Agarwal et al. [3] reported 3.8% mortality and 17.3% morbidity rates for PNL in 78 patients with advanced renal failure and no mortality and <1% morbidity in the 924 patients with normal renal function. The complications included septic shock, disseminated intravascular coagulation, hemorrhage, and death. In our study, most of the complications were minor. There was no mortality in the present study. Significant blood loss that required transfusion during or after surgery occurred in six (20%) patients. Two of these patients required angioembolization. The blood transfusion rates during PNL for staghorn calculus ranges from 17.4 to 82.9% [12, 13]. The average blood loss for uncomplicated 1-stage single puncture PNL in a study was 2.8 g/dl hemoglobin. The blood transfusion rate was 23% in the same study [14].

Incidence of sepsis in our study cohort was higher than other studies in similar population [3]. The reason for increased incidence in our study would have been due tertiary pattern of referral of cases to our institute as well as microbial colonization of pelvicalyceal system due to PCN or stent in situ. Yayicioglu et al. [5] in their study had no increased sepsis rate. In the study by Gonen et al. [15] there was higher incidence of fever and sepsis in preoperative urine culture positive patients. We found higher rates of postoperative sepsis in patients with positive stone culture. All patients who had postoperative sepsis had pelvic urine culture positivity. Stone and first puncture pelvic urine cultures have been shown as an effective predictor of postoperative sepsis by Mariappan et al. [16] also. We again emphasize the role of first puncture urine culture in predicting postoperative sepsis and in guiding appropriate antibiotic therapy postoperatively. Though first pelvic urine culture showed growth postoperatively in some of our patients, none had a frankly purulent urine during PNL. In our practice, if pus is encountered during puncture for PNL we insert a nephrostomy and postpone the procedure.

Our results show that PNL can be done safely with acceptable complication rate and good stone clearance and functional outcome in patients with chronic renal insufficiency. Adequate preoperative stabilization, perioperative supportive measures and availability of replacement therapy as necessary were essential factors in obtaining these favorable results. After PNL, there was an overall decrease in serum creatinine values especially in patients with mild to moderate renal insufficiency. In conclusion, patients with calculus nephropathy can be salvaged using PNL with good improvement in renal function and acceptable morbidity when aggressive preoperative stabilization using drainage procedures (PCN or DJ stenting), adequate treatment of sepsis and good perioperative care are provided.

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