Long-term Functional Outcome of Percutaneous Nephrolithotomy in Solitary Kidney

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OBJECTIVE To evaluate the long-term functional outcome of percutaneous nephrolithotomy (PNL) for calculi in solitary kidneys and to determine factors leading to renal function deterioration.

MATERIALS AND METHODS The computerized files of patients with solitary kidneys who underwent PNL between January 2002 and December 2009 were retrospectively reviewed. Patients with follow-up <2 years were excluded. Complications, secondary procedures, and stone-free rates were recorded. Changes in the renal function were judged by comparing preoperative and postoperative estimated glomerular filtration rates. Preoperative, intraoperative, and postoperative factors that may affect renal function were tested using univariate and multivariate analyses to define risk factors for deterioration of renal function on long-term follow-up.

RESULTS The study included 200 patients (133 men [66.5%] and 67 women [33.5%] with mean age 52.3 ± 11.7 years). Complications were reported in 34 patients (17%). Severe bleeding was noticed in 10 patients (5%). The overall stone-free rate was 89.5%. After a mean follow-up of 3 ± 1.4 years (range, 2-8), there was significant improvement of the estimated glomerular filtration rate from 57 to 64 mL/min ($P < .001$). Thirty-one patients (15.5%) showed deterioration of the renal function. Multiple punctures and postoperative bleeding were independent risk factors for renal function deterioration (odds ratio was 3.7 and 4.5, respectively).

CONCLUSION PNL for calculi in solitary kidneys provided significant improvement in renal function at long-term follow-up. Multiple punctures and severe bleeding are independent risk factors for deterioration of the kidney function. UROLOGY 83: 1011–1015, 2014. © 2014 Elsevier Inc.

Percutaneous nephrolithotomy (PNL) is now the standard treatment for large and complex renal stones.[1,2] It is recommended by American Urological Association guidelines as the primary treatment for staghorn stones either alone or in combination with extracorporeal shockwaves lithotripsy (SWL).[3] PNL for the treatment of renal stones in a solitary kidney represents a special challenge. Patients may benefit from stone retrieval, relief of obstruction, and infection leading to improved renal function and avoidance or postponement of dialysis.[4,5] However, there are risks of complications such as severe hemorrhage that may necessitate embolization or even nephrectomy and concerns about the long-term effects of PNL on the function of a solitary kidney.[6,7]

There are many reports that addressed the issue of PNL in management of stones in a solitary kidney.[4,5,8-11] Whereas some reports had focused on safety and efficacy of PNL in solitary kidneys and included few numbers of patients,[5,9] others had evaluated long-term functional outcome.[10,11] However, most of them did not study factors that affect such functional outcome except Canes et al[11] who had evaluated factors that could predict improvement of renal function after all types of percutaneous surgery in a solitary kidney.

The aim of the present work was to study the long-term functional outcome of PNL for calculi in solitary kidneys and to determine risk factors for renal function deterioration.

MATERIALS AND METHODS

The computer archived data and images of 224 patients who underwent PNL for stones in a solitary kidney between January 2002 and December 2009 were retrospectively reviewed. Patients with congenital renal anomalies (such as horse shoe and polycystic and ectopic kidneys) and those with follow-up shorter

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Table 1. Complications of percutaneous nephrolithotomy in solitary kidneys

Complication	N (%)	Management
- Severe bleeding	10 (5)	- 6 → Angioembolization - 4 → Conservative treatment
- Urinary leakage (>1 wk)	11 (5.5)	- Double-J stent
- Clot anuria	3 (1.5)	- Double-J stent
- Perirenal urinoma	3 (1.5)	- Double-J stent and percutaneous tube drain
- Fever	2 (1)	- Intravenous antibiotics
- Colocutaneous fistula	1 (0.5)	- Double-J stent and TPN for 7 d
- Hydropneumothorax	1 (0.5)	- Intercostal chest tube
- Injury of the renal pelvis	2 (1)	- Prolonged nephrostomy drainage for 5 d
- Deep venous thrombosis	1 (0.5)	- Heparin then oral anticoagulant

TPN, total parenteral nutrition.

than 2 years were not included in the study. Patients with chronic kidney disease (CKD) grade 5 (glomerular filtration rate [GFR] <15 mL/min) were also excluded from the study.

Preoperative patient evaluation included history, clinical examination, urine analysis and culture, serum creatinine estimation, complete blood count, coagulation profile, random blood sugar, and liver function tests. Radiological investigations included excretory urography or noncontrast computed tomography (NCCT) for patients with serum creatinine >1.6 mg/dL.

Percutaneous nephrostomy, for renal drainage, was the initial treatment in 150 patients (75%); 85 of them for relief of upper tract obstruction causing azotemia, and 65 patients for drainage of obstruction associated with infection. The nadir serum creatinine after relief of obstruction was expressed as pretreatment serum creatinine and used for calculation of the estimated glomerular filtration rate (eGFR).

Technique

Using general anesthesia and in prone position, one or more punctures were created under fluoroscopic guidance of retrograde pyelography to the targeted calyces. The tract was dilated using coaxial telescopic dilators up to 30F, and an Amplatz sheath was placed. Small stones were retrieved using forceps, whereas large stones were disintegrated with pneumatic or ultrasonic lithotripters, and then the stone fragments were retrieved by forceps. When multiple punctures were needed, the secondary tracts were dilated to 24F. At the end of the PNL, a 22F nephrostomy tube was placed. It was removed after 48 hours, provided that there was no complication or residual stones, and the nephrostomy tube is draining clear urine. All complications and secondary procedures were recorded. Severe bleeding was defined as intraoperative renal hemorrhage leading to hypotension or postoperative bleeding requiring angiographic embolization. Stone-free rate was evaluated by NCCT before discharge from the hospital and after 3 months for patients who required SWL.

Follow-up

Follow-up protocol included history, urine analysis, serum creatinine estimation, and renal ultrasonography. Further investigations using NCCT were performed for evaluation of patients with stone recurrence or deterioration of the renal function. Cockcroft and Goult[12] formula was used to estimate the GFR from preoperative creatinine and at the last follow-up.

Statistical Analysis

Paired *t* test was used to compare the changes in the preoperative and postoperative serum creatinine and eGFR values. Because the coefficient of variation in determining the GFR by the serum creatinine method can be 15%-20%, we considered >20% increase in the eGFR as improvement, >20% decrease as deterioration, and changes within 20% in eGFR as stationary renal function. Preoperative, intraoperative, and postoperative factors that may affect renal function were tested using univariate (chi-square or independent sample t-test) and multivariate (logistic regression) analyses to define risk factors for deterioration of renal function on long-term follow-up.

RESULTS

The study included 200 patients (133 men [66.5%] and 67 women [33.5%] with mean age 52.3 ± 11.7 years [range, 24-86]). Complications were reported in 34 patients (17%). They were grade 1 in 5, grade 2 in 9, and grade 3a in 20 patients according to Modified Clavien classification.[13] The types and treatment of each complication are summarized in Table 1. At discharge, 163 patients (81.5%) were stone free, 20 (10%) had residual stones for SWL, and 17 (8.5%) had insignificant residual fragments <4 mm causing no obstruction or symptoms. After SWL, 16 patients became stone free, and 4 had insignificant fragments. So, the overall stone-free rate was 89.5%.

Long-term Follow-up

After a mean follow-up of 3.1 ± 1.4 years (range, 2-8), 170 patients (85%) were stone free, 12 (6%) showed the same post-PNL residuals, 9 (4.5%) showed growth of the residuals, whereas 9 (4.5%) had recurrence of the stones. Those cases of recurrence or regrowth of the residuals were managed with SWL.

The mean serum creatinine at last follow-up (1.83 ± 0.7 mg/dL) was significantly lower than preoperative creatinine (2 ± 0.8 mg/dL, $P < .001$). The mean eGFR at last follow-up (64 ± 29.5 mL/min) was significantly higher than preoperative eGFR (57 ± 30 mL/min, $P < .001$). Sixty-two patients (31%) showed improvement in eGFR, 107 (53.5%) showed stationary eGFR, whereas 31 (15.5%) showed deterioration. Only 1 patient (0.5%) developed end stage renal disease and maintained on hemodialysis. This patient was diabetic and hypertensive with preoperative nadir serum creatinine of 4.7 mg/dL, and PNL was performed via 2 punctures with uneventful postoperative course.

On univariate analysis, eGFR category, multiple punctures, supracostal puncture, postoperative severe bleeding,