Long-Term Outcomes of Percutaneous Nephrolithotomy Compared to Shock Wave Lithotripsy and Conservative Management

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Purpose: Percutaneous nephrolithotomy is successful at achieving stone-free status but long-term safety data are lacking. We report our long-term experience with percutaneous nephrolithotomy and compare these results with other treatment modalities.

Materials and Methods: We identified 87 patients treated with percutaneous nephrolithotomy from 1983 to 1984 who continue to receive care at our institution. Retrospective chart review was performed. Long-term results were compared to those of a group of 288 patients with stones treated nonsurgically (controls) and a group of 288 patients treated with shock wave lithotripsy followed for 19 years.

Results: Average followup was 19.2 years (range 12.7 to 23.0). After percutaneous nephrolithotomy new onset renal insufficiency was noted in 9 patients (10.6%), hypertension in 29 (34.1%), diabetes mellitus in 20 (23.5%) and ureteropelvic junction obstruction in 3 (3.5%). Stone recurrence occurred in 32 patients (36.8%). Recurrent stone events were associated with residual fragments after percutaneous nephrolithotomy ($p = 0.049$). Compared to shock wave lithotripsy there were no significant differences in the development of renal insufficiency, hypertension or diabetes mellitus. Stone recurrence was more common following shock wave lithotripsy (53.5%) compared to percutaneous nephrolithotomy ($p = 0.033$). Compared to controls there were no significant differences in the development of renal insufficiency or hypertension. On univariate analysis percutaneous nephrolithotomy was associated with the development of diabetes mellitus ($p < 0.001$) but this association did not persist in multivariate analysis.

Conclusions: At 19 years of followup stone recurrences were less frequent following percutaneous nephrolithotomy compared to shock wave lithotripsy. Recurrent stone events were associated with residual fragments after percutaneous nephrolithotomy. Percutaneous nephrolithotomy was not associated with the development of adverse medical conditions compared to shock wave lithotripsy or conservatively managed stone cases.

Key Words: nephrostomy, percutaneous; kidney calculi; lithotripsy; diabetes mellitus; renal insufficiency

Since its introduction in 1976 PCNL has become an accepted treatment for urolithiasis.[1] Current indications for PCNL are large stone burdens, lower pole calculi, cystine stone disease, abnormal renal anatomy and stones not amenable to ureteroscopy or SWL.[2] Advantages of PCNL compared to open nephrolithotomy and SWL have been noted including superior stone clearance, limited convalescence and cost-effectiveness.[3] Although major complications are possible, analysis has demonstrated overall safety and effectiveness of PCNL for the treatment of complex calculi.[4]

The goal of our study was to evaluate the long-term effects of PCNL on patients followed at our institution. A secondary goal was to compare PCNL long-term outcomes to a previously published matched cohort of patients with stones treated with SWL and patients treated conservatively.[5] In the previously reported case control study comparing SWL to conservative management we found a higher incidence of new onset diabetes mellitus and hypertension after SWL compared to conservative management at 19 years of followup.[5] Finally we assessed recurrent stone events after PCNL to determine if patient, surgical or stone factors predict recurrence.

MATERIALS AND METHODS

Retrospective Chart Review

After institutional review board approval a retrospective chart review of all 754 patients who underwent PCNL for renal or proximal ureteral calculi from March 1983 to July 1984 was performed. This was the first year of extensive PCNL therapy at our clinic using a rapid tract dilation technique. We identified 87 patients who returned for followup at our clinic within the last 5 years. We specifically focused on the development of new onset medical conditions including renal failure/insufficiency, HTN, DM, ureteropel-

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vic junction obstruction, infundibular stenosis, caliceal diverticula and recurrent stone events. Hypertension was defined with diagnosis by a physician and requiring antihypertensive medications. Diabetes mellitus was defined with diagnosis by a physician and requiring oral hypoglycemic agents or subcutaneous insulin. Renal insufficiency was defined as a serum creatinine greater than 1.4 mg/dl in males or greater than 1.2 mg/dl in females. Patients were considered overweight if BMI was greater than 25 but less than 30, obese if BMI was 30 or greater but less than 40 and morbidly obese if BMI was 40 or greater. Recurrent stone disease was defined as passage of stone material or a symptomatic stone identified on radiographic imaging. Those patients with symptoms of stone recurrence or who took part in regular screening through the stone clinic underwent followup radiological imaging in the form of noncontrast computerized tomography of the abdomen and pelvis.

Surgical Procedure and Postoperative Care

PCNL was performed using standard methods previously described.[6] Percutaneous renal access was obtained by interventional radiology in the fluoroscopy suite. The patient was then transferred to the operating suite and the access tract dilated to 28Fr with fascial dilators. The rigid nephroscope without an access sheath was then used to locate the stone(s). Stone fragmentation and extraction were performed primarily with ultrasonic lithotripsy, but also with electrohydraulic lithotripsy and basket extraction. After intraoperative nephrostogram demonstrated no major injuries or residual stone fragments, a 22Fr nephrostomy tube and 6Fr ureteral catheter were left in place. On postoperative day 1 the patients underwent antegrade nephrostogram. If no residual fragments were identified the 6Fr ureteral catheter was removed and the nephrostomy tube was clamped. If the patient tolerated nephrostomy tube clamping for 24 hours the tube was removed and the patient discharged home on postoperative day 2.

Comparison of Outcomes With Other Treatment Modalities

A previously published cohort of 288 patients treated with SWL in 1985 with questionnaire followup in 2004 was used as a comparison group.[5,7] These patients were treated with the Dornier HM3 lithotriptor (Dornier Medical Systems, Inc., Marietta, Georgia). Data collection for this cohort has previously been described.[5,7] Charts for all 288 patients were reviewed. Followup surveys were mailed to the patients in 2004 inquiring about the development of adverse medical conditions and stone recurrences (date, location and mode of treatment). A second comparison group consisted of 288 conservatively treated patients with stones diagnosed in 1985 and followed at our clinic.[5] None of the conservatively treated patients underwent surgical treatment for stone disease.

Statistical Methods

Associations of PCNL features with various outcomes were evaluated using the chi-square and 2-sample t tests. The Wilcoxon rank sum and chi-square tests were used for comparisons among the PCNL, SWL and control groups. Logistic regression models were used for multivariate analysis.

RESULTS

Retrospective Chart Review

Patient demographics and preexisting medical conditions are listed in table 1. At treatment 69 (79.3%) patients had a BMI greater than 25, of which 21 of 87 (24.1%) were obese and 10 of 87 (11.5%) were morbidly obese. Procedural demographics, immediate postoperative complications and stone-free status are presented in table 2. Table 3 shows stone location, size and composition.

Operative and immediate postoperative complications occurred in 33.3% of the PCNL cohort. The development of an immediate postoperative complication was not associated with stone size ($p = 0.497$), preexisting HTN ($p = 0.279$), preexisting DM ($p = 1.000$), preexisting renal insufficiency ($p = 0.533$), patient gender ($p = 1.000$), operative time ($p = 0.635$) or obesity ($p = 0.199$). There was a trend for more complications if forceps extraction was used ($p = 0.061$) compared to ultrasonic lithotripsy ($p = 0.713$), basket extraction ($p = 0.909$) or electrohydraulic lithotripsy ($p = 0.689$). At last followup 32 (36.8%) patients had experienced at least 1 symptomatic stone event since PCNL. A total of 81 recurrent stone events were noted for this cohort. When comparing patient, stone (size, composition, stone-free status) and procedural demographics (including postoperative complications) with recurrent stone events, only the persistence of residual fragments after PCNL was associated with recurrent symptomatic stone disease ($p = 0.049$). Mean followup for patients treated with PCNL was 19.2 years (table 4). At last followup obesity was noted in 41.0% (32) with median patient weight 87 kg (range 44.5 to 149).

PCNL Versus SWL

A comparison between PCNL and SWL is listed in table 5. In the SWL group new onset HTN was noted in 103 patients (36.4%), DM in 48 (16.8%) and renal insufficiency in 14 (5.2%). At last followup obesity was noted in 29.6% (64) of the SWL cohort. Median patient followup weight was 80.9 kg (range 49.2 to 137). A comparison between patients who underwent PCNL and SWL demonstrated no significant difference in the long-term development of HTN, DM or renal insufficiency. On the SWL cohort 53.5% of patients experienced a stone recurrence with 50 patients reporting 1 recurrence, 78 reporting 2 to 5 recurrences, 18 reporting 6 to 9 recurrences and 8 reporting 10 or more recurrences. When comparing SWL to PCNL patients treated with SWL were more likely to experience a stone recurrence ($p = 0.033$).

PCNL Versus Conservative Management

A comparison between PCNL and conservative management is listed in table 6. In the control group new onset hyperten-

TABLE 1. *Patient characteristics and preexisting medical conditions at treatment*

Mean pt age (range)	51.4	(22.1–71.8)
Mean mg/dl preop creatinine (range)	1.13	(0.4–2.7)
Mean BMI (range)	29.6	(19.3–77.0)
No. females (%)	26	(29.9)
No. males (%)	61	(70.1)
No. preexisting medical conditions (%):		
Obesity	31	(35.6)
HTN	21	(24.7)
Renal insufficiency	5	(5.8)
DM	3	(3.5)
UPJ obstruction	2	(2.3)