A Clinical Study of Percutaneous Nephroureterolithotripsy

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Summary: Percutaneous nephroureterolithotripsy was performed a total of 309 times in 225 renal units of 209 patients with upper urinary tract calculi, a mean of 1.37 times per kidney. Residual calculi, 5 mm or greater in diameter, were observed in 3 of 100 kidneys (3%) with single calculi, 12 of 102 kidneys (11.8%) with multiple calculi, and 8 of 23 kidneys (34.8%) with staghorn calculi. The number of sessions, duration of nephrostomy, and the frequency of residual calculi were significantly higher in problem calculi, such as multiple, large and staghorn calculi, than in other calculus types. A combination of percutaneous nephroureterolithotripsy and extracorporeal shock wave lithotripsy was considered to be necessary to improve the efficiency of lithotripsy. Complications included a transient fever, bleeding requiring transfusion and perforation of the renal pelvis in a small number of cases, but these were all mild and could be managed by conservative treatment, alone.

Key words: urolithiasis—renal calculi—ureteral calculi—lithotriptic procedures—percutaneous nephroureterolithotripsy

Introduction

Percutaneous nephroureterolithotripsy (PNL) is a method for removing calculi in the renal pelvis and upper part of the ureter, primarily by endoscopic manipulations through percutaneous nephrostomy. The technique was rapidly accepted in the early 1980’s, and has become an established non-invasive treatment for urolithiasis.

PNL has also been performed aggressively for upper urinary tract calculi since February, 1985 and the results of 100 PNL sessions in 68 patients (Matsuoka, 1986) and 246 sessions in 166 patients (Matsuoka, 1988) have been reported. The present report summarizes the results of 309 sessions in 209 patients (225 renal units). Since this is a very large series accumulated at a single institution, primarily clinical results are described in this report.

Subjects and Methods

Two-hundred-nine patients (225 kidneys) who were admitted to the Department of Urology at Kurume University School of Medicine with a diagnosis of renal and ureteral calculi and who underwent PNL between February, 1985 and May, 1990 were studied. The patients ranged in age from 12 to 82 years with a mean of 48 years and consisted of 151 males and 58 females (male: female = 2.6:1). Of the 225 renal units (right 112, left 113), 176 (78.2%) had renal calculi, 26 (11.6%) had ureteral calculi and 23 (10.2%) had calculi in both the kidney and the ureter. Single calculi were observed in 100, multiple calculi in 102 and staghorn calculi in 23 renal units. Obstructive calculi causing hydronephrosis were seen in 143 renal units. Thirty-seven renal units (16.4%) had a history of open surgery for previous episodes of
Results

PNL was performed 309 times in 225 renal units of 209 patients, a mean of 1.37 times per renal unit. Open surgery was required in 1 renal unit of 1 patient because calicocentesis was impossible and in 2 renal units of 2 patients due to ureteral residual stones after PNL.

1. Frequency of residual stones (Table 1)

<table>
<thead>
<tr>
<th>Stones</th>
<th>Residual stone rate (All sizes)</th>
<th>≥5mm (3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solitary</td>
<td>(n=100)</td>
<td>3 (3%)</td>
</tr>
<tr>
<td>Multiple</td>
<td>(n=102)</td>
<td>12 (12%)</td>
</tr>
<tr>
<td>Staghorn</td>
<td>(n=23)</td>
<td>8 (35%)</td>
</tr>
<tr>
<td>Total</td>
<td>(n=225)</td>
<td>23 (10%)</td>
</tr>
</tbody>
</table>

TABLE 1
Clinical results

Residual calculi including fine granular calculi were observed in 60 (27%) of the 225 renal units after PNL. However, calculi 5 mm or greater in diameter, which were unlikely to be spontaneously discharged, were observed in 23 renal units (10%), and the clinical success rate for PNL was 90%. According to the stone types, residual stones including fine granules were present in 9 (9%) of 100 renal units with single calculi, 38 (37%) of 102 renal units with multiple calculi and 13 (57%) of 23 renal units with staghorn calculi, but stones of 5 mm or greater diameter were noted in 3 (3%), 12 (12%) and 8 (35%) of the renal units with single, multiple and staghorn calculi, respectively.

2. Clinical results and complications of PNL for problem calculi (Table 2)

Large calculi of 3 cm or greater diameter, multiple calculi present in 2 or more calices and staghorn calculi were defined as problem stones, and the results of PNL for those stones were compared with the results for the other stones. Problem stones were observed in 91 renal units, and the number of PNL sessions, duration of nephrostomy and the frequency of residual stones were all significantly higher (p<0.01) for problem stones than for the other stones. Fever of 38°C or higher was observed in 34% (31/91) of the cases with problem stones but only 17% (23/132) of the cases with other types of stones. This

<table>
<thead>
<tr>
<th>Problem stones (n = 91)</th>
<th>Other stones (n = 132)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of PNL sessions</td>
<td>1.8±1.1 (1~5)</td>
</tr>
<tr>
<td>Length of nephrostomy</td>
<td>15.9±14.8 (2~79)</td>
</tr>
<tr>
<td>Cases with residual stones</td>
<td>26 (29%)</td>
</tr>
<tr>
<td>Cases with fever</td>
<td>31 (34%)</td>
</tr>
<tr>
<td>Cases requiring blood transfusions</td>
<td>6 (7%)</td>
</tr>
<tr>
<td></td>
<td>1.2±0.4 (1~3)</td>
</tr>
<tr>
<td></td>
<td>8.1±7.4 (2~60)</td>
</tr>
<tr>
<td></td>
<td>4 (3%)</td>
</tr>
<tr>
<td></td>
<td>23 (17%)</td>
</tr>
<tr>
<td></td>
<td>3 (2%)</td>
</tr>
</tbody>
</table>
PERCUTANEOUS NEPHROURETEROLITHOTRIPSY

is a significant difference \( p<0.05 \). However, transfusions were needed in 7% (6/91) and 2% (3/132) of the cases, respectively, which is not a significant difference.

3. Stone composition (Fig. 1)

Of 223 renal units in which the composition of calculi could be determined, mixed stones of calcium oxalate and calcium phosphate were the most frequent, being observed in 115 renal units (52%). Calcium oxalate stones were found in 47 renal units (21%). Mixed stones of struvite and calcium phosphate were observed in 30 (13%), mixed stones of struvite, calcium oxalate and calcium phosphate in 13 (6%), cystine stones in 9 (4%) and uric acid stones in 5 renal units (2%). Struvite stones, alone, and mixed stones of calcium phosphate and uric acid were observed in 2 renal units (1%), each.

4. Complications (Table 3)

The most frequent complication encountered in 309 PNL sessions was fever of 38°C or above, which was observed after 63 sessions (20.5%). The fever disappeared within 1-2 days in most of the cases, although it continued for 3 days in 4 cases, and for 4 or more days in 5 cases.

The next most common complication was hemorrhaging requiring transfusion, which was observed after 10 sessions (3.2%). The volume of transfusion was 200-800 ml with a mean of 600 ml.

Pelvic perforations occurred during 3 sessions (1%). They were detected by nephrostography on completion of the PNL, but they healed after a few days by ensuring the passage of urine through the nephrostomy.

Pulmonary edema was noted after 3 sessions (1%). Severe pulmonary edema that required assisted ventilation was observed only once, but it resolved within a week after diuretic therapy and fluid management. Pulmonary edema after the other 2 sessions was not severe, and was treated with diuretics.

A pneumothorax occurred during 2 sessions (0.6%), and sustained suction was applied, both times, through the thoracic drain.

Insufficient closure of the nephrostomy, due to stenosis of the pyeloureteral junction, was considered to have been caused by the manipulation of the forceps and the fiberscope, and the descent and impaction of the residual stones from the calices into this site. It was observed twice (0.6%).

There was one case of sepsis (0.3%) in a patient with infected stones after ca-
theterized ureterocutaneostomy, and this patient was treated with intensive chemotherapy without any problems.

Discussion

Historically, calculi were already being removed through a nephrostomy made by open surgery in 1941 (Rupel, 1941). Percutaneous nephrostomy was first utilized for extraction of calculi in 1976 (Fernström, 1976). PNL has been rapidly accepted, worldwide, since the early 1980's.

In the present study, residual stones of 5 mm or greater diameter, which are unlikely to be spontaneously discharged, were observed in 23 (10.2%) of 225 kidneys, and the success rate of PNL was 89.8%. The poorer clinical results, as compared with previous reports, is considered to be related to the introduction of the second generation extracorporeal shock wave lithotripsy (ESWL) in April, 1988. ESWL became the primary lithotriptic therapy. The residual stone rate after PNL increased, because it was usually attempted in cases with large ureteral calculi in which debulking or push-up was impossible, or in cases in which spontaneous stone discharge was not observed after ESWL.

Treatment of the so-called problem stones is a major issue in PNL. According to these results, the number of PNLs, duration of nephrostomy, residual stone rate, and frequency of fever of 38°C or above were all significantly higher in cases with problem stones than in cases with other stones. An increased number of PNL sessions and prolongation of the duration of nephrostomy are considered to exert significant adverse effects on the kidney. Therefore, to preserve renal function and to shorten the therapeutic period, the use of various non-invasive techniques such as ESWL is considered to be important.

Discussions of the procedure of PNL have been exhaustive to date, so only the important points will be reviewed here according to their time sequence. Epidural anesthesia is suited for this procedure, and proper placement of the ureteral occlusion balloon before positioning the patient is important. With this procedure, hydronephrosis is readily induced by administration of a diuretic before calicocentesis, if there is no hydronephrosis. The puncture is easier and more reliable if performed under ultrasonic guidance than under fluoroscopy. After completion of calicocentesis, the nephrostomy is diluted. Complications such as renal pelvic perforation can be avoided by careful manipulation, if necessary, under fluoroscopy.

Lithotripsy can be performed using ultrasound, electrohydraulic shock waves, and laser, but ultrasound is safe and efficient. However, ultrasound lithotripsy is possible only with the use of rigid nephroscopes, and calculi or residual fragments in the calices and ureter must be managed with electrohydraulic shock waves or lasers, using a flexible nephroscope. These lithotriptic modalities may seriously damage tissues other than the calculi, and they should be used with caution. Recently, pulsed dye lasers (Watson, 1986; Dretler, 1987), which cause less tissue damage, have become more widely accepted, and have exhibited a high lithotriptic effect.

The most frequent complication of PNL was fever of 38°C or above, observed in 20% of the cases. However, the fever was resolved within 1-2 days in most cases and posed no major problem. In cases complicated with urinary tract infections, chemotherapy before PNL is considered to be important. Hemorrhage can be managed conservatively by pelvic tamponade and compression. Renal pelvic perforations will cure spontaneously if care is
taken to ensure the flow of urine through the catheter placed in the nephrostomy. For prevention of pulmonary edema, the balance of the lavage fluid was checked every 15-20 minutes and the procedure was cancelled when the absorbed fluid volume exceeded 1.5L. Determination of the site of puncture was essential for the prevention of a pneumothorax. If a pneumothorax develops, deaeration through the thoracic drain is considered to be beneficial and results in an early recovery. If there is insufficient closure of the nephrostomy, ureteral catheterization may alleviate the stenosis and contribute to the closure of the fistula.

All the complications of PNL that were encountered could be managed conservatively, but anticipation and efforts to prevent any complication that may occur is considered to be important. The assurance of safety is of utmost importance in PNL.

References


