Original article

Tubeless percutaneous nephrolithotomy: Experience of 1000 cases at a single institute

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A B S T R A C T

Objective: To assess the safety and efficacy of tubeless percutaneous nephrolithotomy (PCNL).

Materials and methods: Since January 2001, 1000 consecutive tubeless PCNLs performed at our hospital were enrolled into this retrospective chart review. The average age of the patients (659 males and 341 females) was 54.4 ± 12.6 years, and 55 patients were 75 years old or older. The stone characteristics were 490 non-complete staghorn kidney stones, 218 ureteral stones, 119 kidney + ureteral stones and 173 complete staghorn stones. The mean stone size was 3.5 ± 2.0 cm, and 200 patients had stone size ≥5.0 cm. The average operative time was 78.0 ± 29.4 minutes. The stone free rates were 78.8%, 100%, 84.9% and 45.0% for kidney, ureter, kidney + ureter and complete staghorn stones, respectively, with an overall stone free rate of 78.3%. The average postoperative hospital stay was 3.6 ± 2.1 days, and the blood transfusion rate was 2.4%. Postoperative fever was noted in 104 patients, and urosepsis was noted in 13 patients. Pulmonary complication included hydrothorax in 5 patients, hemothorax in 2 patients, pneumothorax in 2 patients and acute pulmonary edema in 1 patient. Cardiovascular complications included congestive heart failure in 1 patient and pneumomediastinum in 1 patient.

Conclusion: Our study demonstrated that sith adequate hemotasis, tubeless modification is a safe modality for PCNL.

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1. Introduction

Removing kidney stones via percutaneous access is a less invasive and more effective procedure than traditional open stone surgery. The advantages of percutaneous nephrolithotomy (PCNL) over open urinary stone surgery include lower morbidity and mortality rates, faster recovery, easier secondary procedures, and greater cost effectiveness.¹ Although the introduction of shock wave lithotripsy and advances in endourological equipment and intracorporeal lithotriptors have changed the way urinary stones are managed, PCNL still plays an important role in the treatment of complicated upper urinary tract stones.² In 2005, the American Urology Association stated that PCNL should be the standard treatment of choice for the primary approach in patients with large or staghorn stones.³ Placement of a nephrostomy tube at the end of PCNL was a standard procedure for PCNL in the past. The purpose of this indwelling nephrostomy tube is to provide adequate urinary drainage, hemostatic tamponade of the access tract, and preserve renal access for a possible second-look PCNL. However, the need for placing a nephrostomy tube has been challenged by several authors since 1997. Many reports have confirmed the safety and efficacy of tubeless PCNL, and demonstrated the benefits of a lower analgesic requirement and earlier hospital discharge with no increase in morbidity.⁴–⁶ However, the results of tubeless PCNL with a large number of patients in a single institute have not been previously reported. Tubeless modification for percutaneous renal surgery has been performed at our hospital since 2001. As experience accumulated, we became familiar with tubeless modification and it soon became a routine procedure for PCNL at our hospital. To clarify the efficacy of tubeless PCNL, in this study we retrospectively reviewed the clinical results of the first 1000 consecutive cases of tubeless PCNL at our hospital.

2. Materials and Methods

Between January 2001 and March 2014, 1000 consecutive tubeless PCNLs were performed at our hospital. The indications for
PCNL included a large stone burden, multiple stones, calyceal stones, urinary tract anatomic anomalies, and extracorporeal shock wave lithotripsy or ureteroscopy failure for patients with upper urinary tract stones. All of the PCNLs were performed by the same experienced urology team using standard operative procedures.

Before renal puncture, an occlusion balloon catheter was inserted cystoscopically in the supine lithotomy position to allow for retrograde saline infusion and prevent downward migration of stone fragments during lithotripsy. The renal access tract was obtained by ultrasound-guided puncture by the same urology team with the patient in the prone position. The access tract was dilated with coaxial metal dilators to 26–28 F depending on the stone size and renal anatomy. All patients in this study received a single access tract. The holmium–yttrium–aluminum–garnet laser and pneumatic lithotripter were used alone or in combination to disintegrate the stones.

After the stones had been disintegration and extracted, a 6 or 7 F double-J catheter was inserted in an anestograde fashion for postoperative urine drainage. The irrigation fluid was then changed to distilled water. The bleeding points of the collecting system and access tract were cauterized with a self-made long electrode probe attached to the handpiece of a conventional electric cauterizer as described previously. For patients in whom the bleeding points could not be well controlled by cauterization, oxidized regenerated cellulose (Surgicel®, Ethicon, Inc., Somerville, NJ) strips were used to pack and tamponade the renal parenchyma to achieve more effective hemostasis. The percutaneous wound was then closed with suture without the placement of the nephrostomy tube in the remaining patients. A Foley catheter was inserted into every patient for urinary drainage, and the catheter was removed in the next morning. Because a double-J catheter had been inserted in every patient, we did not exclude the patients with residual stones and perforation of the collecting system from tubeless PCNL. Patient age, stone characteristics, stone size, operative time, postoperative hospital stay, urinary tract infection rate, transfusion rate, and other complications were recorded and analyzed by retrospective chart review. The stone size was measured on a preoperative kidney–ureter–bladder film or computed tomography performed immediately after the procedure. A body temperature above 38.5°C after the operation was defined as postoperative fever. Sepsis was defined as patients with systemic inflammatory response syndrome with suspected infection.

3. Results

The age of the patients ranged from 28 years to 89 years (mean 54.4 ± 12.6 y), with 55 patients being 75 years or older. Of the 1000 cases of PCNL, 659 were performed in male patients and 341 in female patients. The stone characteristics were 490 noncomplete staghorn kidney stones, 218 ureteral stones, 119 kidney + ureteral stones (concomitant kidney and ureteral stones), and 173 complete staghorn stones (Table 1). Table 1

<table>
<thead>
<tr>
<th>No. of patients with a stone size</th>
<th>±</th>
<th>Complete staghorn stones</th>
<th>5.7 ± 2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone characteristics</td>
<td></td>
<td>Renal stones except complete staghorn stones</td>
<td>490</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reuter stones</td>
<td>218</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renal and ureteral stones</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete staghorn stones</td>
<td>173</td>
</tr>
<tr>
<td>Mean stone size (cm)</td>
<td></td>
<td>Renal stones except complete staghorn stones</td>
<td>3.3 ± 1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reuter stones</td>
<td>2.1 ± 0.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renal and ureteral stones</td>
<td>3.5 ± 2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete staghorn stones</td>
<td>5.7 ± 2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No. of patients with a stone size &gt;5 cm</td>
<td>200</td>
</tr>
</tbody>
</table>

PCNL = percutaneous nephrolithotomy.

Table 1 Characteristics of 1000 cases of tubeless PCNL.

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>54.4 ± 12.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>659</td>
</tr>
<tr>
<td>Female</td>
<td>341</td>
</tr>
</tbody>
</table>

4. Discussion

Percutaneous renal surgery is a common urological procedure for the treatment of upper urinary tract stone disease, ureteropelvic junction stenosis, and tumors of the upper urinary tract. When performing PCNL, placement of a nephrostomy tube after completion of stone extraction was traditionally considered to be standard practice. Since the first report of tubeless PCNL in 1997 by Bellman et al, several investigations have focused on reducing morbidity and improving postoperative patient comfort without sacrificing the safety of the procedure in select patients. Furthermore, several prospective randomized studies concerning the safety and efficacy of tubeless PCNL have been reported. Desai et al evaluated postoperative outcomes among tubeless, conventional large-bore nephrostomy drainage, and small-bore nephrostomy drainage following PCNL in a prospective randomized study including 30 patients in 2004, and their results supported that tubeless PCNL is associated with less postoperative pain.
and urinary leakage and shorter hospital stay. A randomized comparison of tubeless and standard PCNL in 220 cases in 2008 by Agrawal et al\(^4\) demonstrated that tubeless PCNL reduced postoperative urinary leakage and local pain and minimized hospital stay without increasing morbidity.

With the growth of experiences, the application of tubeless PCNL in more complicated stone disease has been reported. In 2005, Shah et al\(^{12}\) advocated that tubeless PCNL was safe and effective even in patients with a solitary kidney, or with multiple renal access tracts. In 2006, we reported our experience of performing tubeless PCNL in patients with a large stone burden, and our results showed that it was safe and efficacious.\(^3\) The safety and efficacy of simultaneous bilateral tubeless PCNL has also been investigated. A prospective randomized controlled study was performed to evaluate the feasibility and outcomes of staged versus simultaneous bilateral tubeless PCNL for 99 patients with bilateral renal staghorn stones by Wang et al\(^{13}\) in 2011. Their results showed that the procedure was a safe, efficacious and cost-effective option for bilateral renal staghorn calculi.\(^3\) Tract cauterization and hemostasis tubeless PCNL has become the standard procedure when performing PCNL in every patient at our hospital, even in geriatric patients, patients with large stone burden, and patients with bleeding tendency or receiving anticoagulant therapy.\(^\text{2,3,14-16}\)

Renal hemorrhage is a life-threatening complication of PCNL, especially when the access tract has not been tamponaded with a nephrostomy tube. Several studies have reported attempts to minimize postoperative hemorrhage. In 2004, we reported our experience of cauterizing the access tract for hemostasis after PCNL, leading to more patients being suitable for tubeless modification.\(^3\) Coagulating agents have also been used to seal the access tract and improve hemostasis. In 2003, Mikhail et al\(^{16}\) retrospectively reviewed 43 patients who underwent tubeless PCNL, 20 of whom received percutaneous tracts injected with fibrin sealant at the conclusion of the procedure. Their results showed a shorter hospital stay in the patients receiving the fibrin sealant than the control group. In 2006, Aghamir et al\(^{17}\) reported sealing the nephrostomy tract in 10 patients and leaving it unsealed in another 10 patients. Their results showed that sealing the nephrostomy tract with Surgicel after totally tubeless PCNL did not decrease bleeding or extravasation from the tract. However, the hospital stay and transfusion rate were not reported in this series.\(^3\) A prospective randomized trial to assess the safety and efficacy of fibrin sealant in tubeless PCNL in 63 patients was reported by Shah et al\(^{10}\) in 2006. They reported that instillation of fibrin glue was safe and associated with less postoperative pain and lower analgesic requirement. In our series, we sealed the access tract with Surgicel initially in the patients with hemorrhage who were not well controlled by tract cauterization, and then subsequently as routine in all patients. We did not evaluate the efficacy of Surgicel in this report as we did not include a randomized control group.

Several studies with a large number of patients have reported on the efficacy and complications of traditional PCNL, and the most common complications were hemorrhage and fever. In 1985, Segura et al\(^{18}\) reported their results of 1000 PCNL procedures, and revealed a transfusion rate of 3.0% with six patients needing angioembolization for severe postoperative hemorrhage. Although the postoperative urinary tract infection and fever rates were not reported, a pulmonary complication with pneumothorax was noted in one patient. Jones et al\(^{19}\) reviewed 1000 cases of PCNL performed from 1981 to 1985 and disclosed a mortality rate of 0.7% and a blood transfusion rate of 8.4%. Six (0.6%) patients with troublesome postoperative hemorrhage underwent angioembolization, and 75 patients (7.5%) experienced sepsis after the operation. A recent retrospective review of 811 traditional PCNL procedures was published by Tefekli et al\(^{20}\) in 2008, and the authors revealed a blood transfusion rate of 10.9% and postoperative fever rate of 2.8%. In one of our previous studies, we showed that tubeless PCNL decreased postoperative analgesic requirement and shortened the postoperative hospital stay.\(^3\) The results of the current study showed a reasonable complication rate for tubeless PCNL with a transfusion rate of 2.4%.

Our experiences of 1000 tubeless PCNLs suggest that with adequate hemostasis, tubeless PCNL is a safe procedure for the treatment of urinay tract stone disease even in patients with complicated stones.

### Conflict of interest

The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

### References