Tubeless percutaneous nephrolithotomy for complex renal stone disease: single center experience

John B. Malcolm, MD,[1] Ithaar H. Derweesh, MD,[1,2] E. Keith Brightbill, MD,[1] Reza Mehrazin, MD,[1] Christopher J. DiBlasio, MD,[1] Robert W. Wake, MD[1,2]

[1]Department of Urology, University of Tennessee Health Science Center, Memphis, Tennessee, USA

[2]Urological Service, Memphis Veterans Affairs Medical Center, Memphis, Tennessee, USA

MALCOLM JB, DERWEESH IH, BRIGHTBILL EK, MENRAZIN R, DIBLASIO CJ, WAKE RW. Tubeless percutaneous nephrolithotomy for complex renal stone disease: single center experience. The Canadian Journal of Urology. 2008;15(3):4072-4077.

Objective: *Tubeless percutaneous nephrolithotomy (PCNL) has become an option for treatment of renal stone disease, though no clearly defined algorithm exists for selection of patients suitable to tubeless PCNL. We investigated our experience with tubeless PCNL to evaluate its safety and efficacy for cases of complex renal calculi.*

Patients and methods: *Retrospective review of all tubeless PCNLs performed for complex renal calculus disease (bilateral stones, partial/complete staghorn, infundibular stenosis/calyceal diverticulum, pre-existing renal insufficiency) between January 2001 and January 2006. All patients had a ureteral stent placed in an antegrade fashion following stone treatment, and a foley catheter remained in place overnight. No patient received nephrostomy tube (NT). Imaging (CT or KUB) was obtained at the first outpatient follow-up visit. Patient demographics, incidence of complications, clinical outcomes and stone-free rates were noted and analyzed. "Stone free" was defined as negative imaging (CT or KUB).*

Results: *Forty-two patients (47 renal units) were treated with tubeless PCNL for complex renal stone disease (5 bilateral, 25 total/partial staghorn, 12 renal insufficiency, and 10 infundibular stenosis or calyceal diverticulum). Mean age was 58.2 ± 9.4 years. Mean length of hospital stay was 2.1 days. Mean preoperative and postoperative hematocrit were 40.5 ± 4.5 and 37.2 ± 5.8, respectively ($p = 0.001$). Single-procedure stone free rate was 74.5%, and the two-procedure stone free rate was 91.5%. One patient (2.4%) required a blood transfusion and one patient (2.4%) developed urosepsis.*

Conclusions: *Tubeless PCNL is safe and effective and can be utilized in cases of complex renal stone disease.*

Key Words: complex renal calculi, percutaneous nephrolithotomy, staghorn calculus, treatment

Introduction

Percutaneous nephrolithotomy (PCNL) is a well-accepted technique for treatment of large renal calculi. Stone-free rates exceeding 95% have been reported for large or complex renal stones.[1,2] Since the introduction of PCNL, a percutaneous nephrostomy tube (NT) has been placed following stone removal to facilitate drainage, promote hemostasis, and maintain access for second stage procedures. More recently, tubeless PCNL (without NT) has demonstrated good efficacy and decreased morbidity in select patients. Tubeless PCNL has demonstrated advantages with respect to decreased postoperative pain, shorter hospital stay, and reduced convalescence.[3-6] However, no clearly-defined algorithm exists for selection of patients suitable to tubeless PCNL. We examined our experience with tubeless PCNL to determine its safety and efficacy for complex renal stone cases.

Accepted for publication April 2008

Address correspondence to Dr. Robert W. Wake, Department of Urology, University of Tennessee Health Science Center, 901 Madison Avenue, Room 409, Memphis, TN 38163, USA

Methods

We performed a retrospective single center review (Memphis Veterans Affairs Medical Center, Memphis, TN, USA) of 89 consecutive tubeless PCNL cases performed between January 2001 and January 2006. Of these, 47 cases were considered uncomplicated: involving a unilateral stone burden limited to the renal pelvis and/or a single calyx, normal collecting system anatomy, and normal renal function. These were excluded from our analysis. The remaining 42 cases (47 renal units) were considered complex: involving bilateral stones, total or partial staghorn calculi, infundibular stenosis, calyceal diverticulum, or pre-existing azotemia (serum Creatinine > 1.5 mg/dl). We selected the complex cases for an investigation of complications and outcomes.

Our technique has been described previously.[4] Briefly, after obtaining percutaneous wire access in cooperation with the Interventional Radiology service, balloon dilation is performed and a 30 French working sheath (NephroMax High Pressure Nephrostomy Balloon Catheter, Boston Scientific, Natick, MA, USA) is advanced for rigid and flexible nephroscopy. Under direct vision with a rigid nephroscope, stones are fragmented and removed with an ultrasonic lithotrite. Flexible nephroscopy with laser lithotripsy is performed when needed. Multiple accesses were not utilized in this series. After stone treatment, the collecting system is cleared endoscopically and fluoroscopically, and antegrade placement of a double-J ureteral stent is performed. The working sheath is then removed and the nephrostomy site is closed. Indwelling foley catheter is removed on postoperative day one. Following discharge, patients return in 2-3 weeks for imaging [non-contrast enhanced computed tomography (NCCT) or plane film (KUB)] and stent removal if no ancillary procedure is indicated. "Stone free" is defined as negative imaging (CT or KUB).

Medical records were surveyed for patient demographics (age, sex, race, ASA Class), stone burden (location, morphology, size) and renal anatomy, length of hospitalization, complications and outcomes (stone free rate), and ancillary procedures.

Results

Table 1 demonstrates patient demographics and disease characteristics. 89 patients were treated with tubeless PCNL at the Memphis VAMC between January 2001 to January 2006. Forty-two patients with complex renal stone disease (40 male/2 female, 32 Caucasian/10 African-American or Other, mean age 58.2 ± 9.4 years, mean BMI 27.8 ± 4.7) underwent 47 tubeless PCNL procedures during that time period (5 bilateral, 25 total/partial staghorn, 12 renal insufficiency, and 10 infundibular stenosis or calyceal diverticulum). Mean stone burden (greatest diameter) was 3.99 cm (range: 1.4 cm-10 cm).

TABLE 1. **Patient demographics and disease characteristics**

Variable	Value
Patients	42
Mean age (years)	58.2 ± 9.4
Sex (male/female)	40 (95%)/2 (5%)
Race (Caucasian/ African-American-Other)	32(76%)/10(24%)
Median ASA class (range)	2 (1-4)
Mean BMI (kg/m^2)	27.8 ± 4.7
Mean stone burden (cm) (range)	3.99 (1.4-10)
Total/partial staghorn calculus (n/%)	25 (53%)
Renal insufficiency (serum creatinine > 1.5 mg/dl) (n/%)	12 (26%)
Infundibular stenosis/ calcyeal diverticulum (n/%)	10 (21%)

TABLE 2. **Outcomes and complications**

Variable	Value
Mean hospital stay	2.1 ± 1.0
Stone free (number of renal units/%)	
After one procedure (%)	35 (74.5%)
After two procedures (%)	43 (91.5%)
Residual stones after primary PCNL	12 (25.5%)
Subsequent treatments (n/%)	10 (21.3%)
SWL	5 (42%)
URS	3 (25%)
URS and SWL	1 (8%)
Repeat PCNL	1 (8%)
Surveillance	2 (17%)
Change in hematocrit (preoperative versus postoperative) (range)	3 (0 - 18.3)
Change in creatinine (preoperative versus postoperative) (range)	0.0 (0.0-0.9)
Complications (n/%)	2 (4.8%)
Postoperative urosepsis	1 (2.4%)
Blood transfusion	1 (2.4%)

Table 2 shows outcomes and complications. Mean length of hospital stay was 2.1 ± 1.0 days. Mean preoperative and postoperative hematocrit were 40.5 ± 4.5 and 37.2 ± 5.8, respectively (p = 0.001). Mean preoperative serum creatinine was 1.4 mg/dl (range 0.6-3.7) and mean postoperative serum creatinine was 1.4 mg/dL (range 0.6-3.4). Mean change in serum creatinine was 0.0 mg/dl. Single procedure stone free rate was 74.5%, and the two procedure stone free rate was 91.5%. There was 2.4% that required transfusions and 2.4% suffered urosepsis.

Of the 12 patients (12 renal units) who were not stone free after tubeless PCNL, 10 patients underwent subsequent treatments. Five (42%) underwent shockwave lithotripsy (SWL), 3 (25%) underwent ureteroscopy (URS), and 1 (8%) underwent URS and SWL. One patient (8%) underwent repeat PCNL. Two patients with small (< 2mm) residual stones elected observation only. Two patients were not stone free after secondary PCNL and secondary SWL.

Discussion

Tubeless PCNL has demonstrated good efficacy and decreased morbidity in select patients.[3-6] Early in our experience, we restricted tubeless PCNL to relatively straightforward stone cases with moderate stone burden, normal renal anatomy, and limited comorbid conditions. With growing experience, we have expanded our use of tubeless PCNL to include virtually any patient undergoing PCNL, Figure 1. From January 2001 to January 2006, we performed tubeless PCNL on 47 renal units in 42 patients with complex renal stone disease.

Perioperative complications (4.8%, Table 2) in our series are not unlike those reported for the traditional PCNL with NT.[1] We identified one case of postoperative drop in hematocrit with tachycardia that was managed with a two unit blood transfusion and close observation. 24 hours later, hemodynamic and hematologic stability were achieved. An additional case of urosepsis was

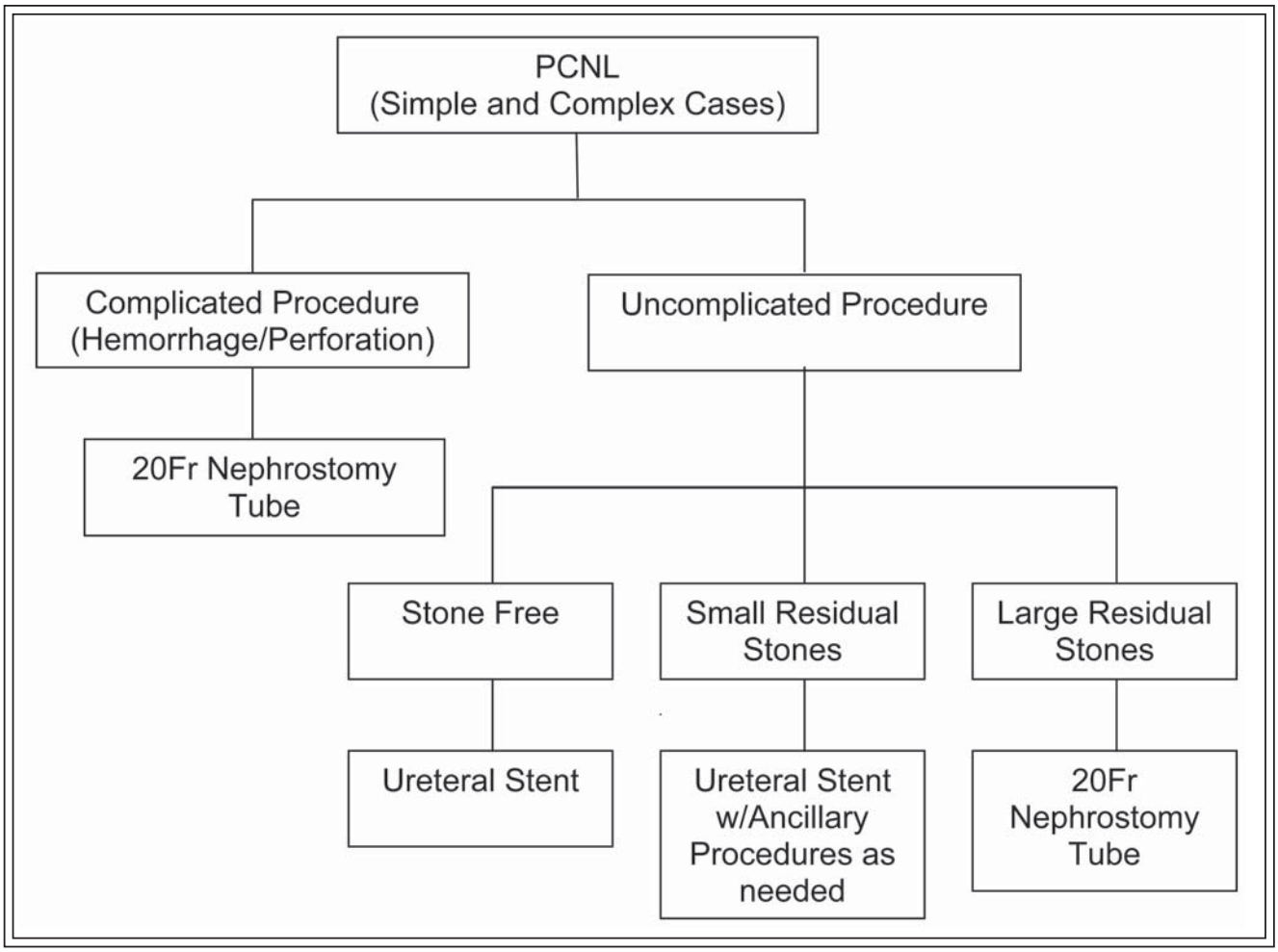

Figure 1. Algorithm for post-PCNL upper tract drainage

identified in a spinal cord patient who was treated preoperatively with culture specific antibiotics, but who postoperatively required ICU admission for 48 hours due to hypotension with associated bacteremia. This patient's condition stabilized with IV antibiotics. No further intervention was required. We did not identify any cases of urinoma or hydrothorax; all percutaneous nephrostomy access tracks were obtained via a subcostal route. We performed bilateral tubeless PCNL in five patients, with no perioperative complications. Traditional PCNL with NT has been associated with similarly low rates of blood transfusion, urosepsis, hydrothorax, and urinoma.[1] The tubeless variation on traditional PCNL does not appear to add any increased risk of perioperative complications,[5,7,8] even in the setting of complex renal stone disease. Perhaps significantly, no patients in our series were treated with multiple accesses. Others have reported successful outcomes with tubeless PCNL in multiple access scenarios,[7] but to date we have not had experience with this treatment strategy.

With respect to managing the morbidity and perioperative complications of PCNL, it appears that little is lost by abandoning the NT in favor of an internalized stent. In our view, the solitary offering of NT after PCNL is for maintaining access for second look PCNL. Our stone free rates after a single PCNL treatment (74.5%) and after ancillary procedures (91.5%) are similar to those reported in the literature for traditional PCNL with nephrostomy tube (NT) and liberal use of second look PCNL.[1] Kim et al reported on a series of 106 renal units treated with PCNL, noting a stone free rate of 31% (by noncontrast CT evaluation) after initial PCNL and 95% after secondary PCNL. Based on the low stone-free rate (confirmed by NCCT) after a single PCNL treatment, this group advocates routine use of NT to maintain access for secondary PCNL.[1] Other series (ours included) advocating tubeless PCNL have reported higher stone-free rates after a single PCNL treatment (79%-92%).[5,7,9] Of note, in most published tubeless PCNL series, evaluation for residual stones relied on ultrasound or plain film radiography.[3,5,7] It is likely that stone-free rates are overestimated in the absence of CT for the evaluation of residual stones after PCNL.[10] Our follow-up consisted predominantly of NCCT imaging (75%). However a significant number of patients, particularly those treated earlier in our series, were followed up with KUB only (25%), perhaps allowing for an overestimation of stone free status.

Ten renal units (21%) were treated with delayed ancillary procedures following PCNL. The majority of ancillary procedures were noninvasive (SWL = 6) or minimally invasive (URS = 4) and were successful in clearing the residual stone burden (8/10). One patient underwent follow-up SWL and persistent small (< 2 mm) lower pole calcifications were visible on follow-up NCCT. The patient elected to forego further treatment. One patient underwent repeat PCNL. This was a case of a morbidly obese patient (BMI 37) with suboptimal access and poor visibility at the first PCNL; the available access offered no utility in treating the stone so a stent was placed, the access was removed, and the patient returned 1 month later for a second PCNL via an improved access. We feel that these cases illustrate an unfortunate reality of complex renal stone management: multiple treatments by various modalities—whether primary PCNL followed by second-look PCNL or by SWL or URS—may be necessary to achieve the desired outcome. Although second look PCNL may have obviated delayed ancillary procedures in selected patients, we are skeptical as to whether such a management strategy is advantageous compared with less invasive alternatives for most patients. On the other hand, Goel et al have reported use of second look PCNL with local anesthesia and sedation only,[11] and while this approach was not part of our institutional protocol, we acknowledge that such a management strategy may represent a viable alternative and compares favorably to use of second look URS or SWL to clear residual stones in select patients.

In the current health care environment, cost-effectiveness is an important measure of competing treatment strategies. The cost of managing residual stones following PCNL depends on the modes of imaging used, length of hospital stay, utilization of anesthesia and operating room time, and choice of ancillary procedures. In general, ureteroscopy is less costly than SWL, SWL may be cost effective for small stones, and PCNL is considered the most cost effective treatment for stones > 2 cm.[12] However, a cost comparison of second look PCNL versus staged outpatient SWL or URS has not previously been reported. This is an important issue that merits further investigation.

Weaknesses of this study include its retrospective design and lack of a control group. We have abandoned routine use of NT at our institution, so a contemporary, institutional control group is not available. We also acknowledge the lack of uniformity in follow-up imaging and the potential for error in identifying small residual stones with KUB. Nevertheless, we have achieved good clinical outcomes with minimal perioperative morbidity in a substantial series of

tubeless PCNL for complex renal stone cases. As we continue to expand the application of tubeless PCNL, future study is needed to investigate the utilization of multiple access sites in the tubeless PCNL paradigm, hopefully reducing further the need for ancillary procedures.

Conclusions

Tubeless PCNL is a safe and effective procedure that can be performed in cases of complex renal stone disease, including bilateral stones, partial and total staghorn stones, abnormal renal anatomy, and renal insufficiency. Stone free and complication rates are similar to those reported in the literature for conventional PCNL with NT and for tubeless PCNL with uncomplicated stone disease. □

References

1. Kim SC, Tinmouth WW, Kuo RL, Paterson RF, Lingeman JE. Using and choosing a nephrostomy tube after percutaneous nephrolithotomy for large or complex stone disease: a treatment strategy. *J Endourol* 2005;19(3):348-352.
2. Wong C, Leveillee RJ. Single upper-pole percutaneous access for treatment of > 5-cm complex branched staghorn calculi: is shockwave lithotripsy necessary? *J Endourol* 2002;16(7):477-481.
3. Bellman GC, Davidoff R, Candela J, Gerspach J, Kurtz S, Stout L. Tubeless percutaneous renal surgery. *J Urol* 1997;157(5):1578-1582.
4. Delnay K, Wake RW. Safety and efficacy of tubeless percutaneous nephrostolithotomy. *World J Urol* 1998;16(6):375-377.
5. Lojanapiwat B, Soonthornphan S, Wudhikarn S. Tubeless percutaneous nephrolithotomy in selected patients. *J Endourol* 2001;15(7):711-713.
6. Goh M, Wolf JS Jr. Almost totally tubeless percutaneous nephrolithotomy: further evolution of the technique. *J Endourol* 1999;13(3):77-180.
7. Shah HN, Kausik VB, Hegde SS, Shah JN, Bansal MB. Tubeless percutaneous nephrolithotomy: a prospective feasibility study and review of previous reports. *Br J Urol* 2005;96(6):879-883.
8. Karami H, Gholamrezaie HR. Totally tubeless percutaneous nephrolithotomy in selected patients. *J Endourol* 2004;18(5):475-476.
9. Brusky JP, Parekh A, Kaptein J, Bellman GC. Need for ancillary procedures among patients undergoing tubeless percutaneous renal surgery for nephrolithiasis. *J Endourol* 2007;21(7):692-694.
10. Park J, Hong B, Park T, Park HK. Effectiveness of noncontrast computed tomography in evaluation of residual stones after percutaneous nephrolithotomy. *J Endourol* 2007;21(7):684-687.
11. Goel A, Aron M, Hemal AK, Gupta NP. Simple method of residual stone retrieval through the nephrostomy catheter after PCNL: point of technique. *Int Urol Nephrol* 2002;34(2):183-184.
12. Lotan Y, Pearle MS. Economics of stone management. *Urol Clin North Am* 2007;34(3):443-453.

EDITORIAL COMMENT

The authors report their retrospective experience with tubeless percutaneous nephrolithotomy (PCNL). While the literature to date on the tubeless technique has generally been restricted to patients undergoing relatively straightforward procedures (small stone burdens and normal anatomy), this manuscript is unique in that it describes the application of the tubeless concept to patients with more complicated stone disease. Patients in this series had total or partial staghorn stones, underwent bilateral procedures, suffered from renal insufficiency or had infundibular stenosis or calyceal diverticuli. All tracts were subcostal, procedures were performed via a single tract and all patients underwent antegrade stent placement at the completion of each procedure. The authors report their stone free rates, the need for ancillary procedures and complications in this challenging population.

A recently reported randomized trial[1] has demonstrated the tubeless technique is associated with less pain in the immediate postop period and associated with shorter hospital stays in the uncomplicated patient with comparable stone free rates to those in whom a nephrostomy tube was placed. While these are obvious advantages, the application of the tubeless technique in the patient with a more complex stone problem, does mandate some pause and reflection.

The main issue raised by this paper, is whether the tubeless technique compromises the efficacy of conventional PCNL, forcing the need for additional interventions, and their associated inconvenience, morbidity and cost among those patients with more complex stone problems. In this series, the single procedure stone free rate was 74.5% which may be an inflated number given the use of KUB x-ray imaging to assess stone free rates in a quarter of the patients. With the application of ancillary procedures such as ureteroscopy (URS) and shock wave lithotripsy (SWL), the two procedure stone free rate increased to 91.5%. Ten (25%) of the patients required ancillary procedures at a later date. Complications were minimal in this report. Only one patient required blood transfusion and there was one case of urosepsis. The mean hospital stay was 2.1 +/- 1.0 days.

When considering the merits of the tubeless technique especially if there is a significant chance that additional treatment(s) will be required, the issues of efficacy, patient convenience and ancillary treatment cost need to be addressed. In terms of efficacy, it could be argued that by leaving a nephrostomy tube and having the ability to perform 2nd look flexible nephroscopy, is a more definitive treatment strategy for those patients in whom stone fragments are known or likely to be present after the initial PCNL. The ability to physically remove fragments at the time of flexible nephroscopy and prior to hospital discharge, ensures a quicker stone free state than delayed salvage SWL or URS. In our own PCNL series which employed the liberal use of flexible nephroscopy, our stone free rate at the time of hospital discharge was 89.1%.[2] With the judicious use of

flexible nephroscopy the potential need for a stent, a well-recognized source of patient morbidity and inconvenience is also obviated. Finally with respect to cost, the authors correctly point out that a financial comparison of second look PCNL versus staged outpatient SWL or URS has not been conducted. Costs vary widely depending on the jurisdiction, and are not generalizable to other institutions or countries. Admittedly however, the application of 2nd look flexible nephroscopy under intravenous sedation or local anesthesia prior to hospital discharge is likely to compare favorably with either URS or SWL. At my institution most 2nd look flexible nephroscopy procedures are performed with no anesthesia or IV sedation in our clinic procedure room. The 2nd look procedure does not prolong the patients' hospital stay, typically requires minimal disposable items and is therefore not a significant cost burden.

The authors are to be commended for their courage and determination in attempting to advance percutaneous stone surgery. Before adopting an expanded application of tubeless PCNL into mainstream practice however, it is essential that we thoroughly assess patient outcomes and the economics of this practice.

Hassan Razvi MD FRCSC
Chair, Division of Urology
Schulich School of Medicine and Dentistry
University of Western Ontario
London, Ontario, Canada

References

1. Agrawal MS, Agrawal M, Gupta A, Bansal S et al. A randomized comparison of tubeless and standard percutaneous nephrolithotomy. *J Endourol* 2008;22(3):439-442.
2. Duvdevani M, Razvi H, Sofer M, Bieko D et al. Contemporary percutaneous nephrolithotripsy: 1585 procedures in 1338 consecutive patients. *J Endourol* 2007;21(8):824-829.