JOURNAL OF ENDOUROLOGY
Volume 21, Number 12, December 2007

DOI: 10.1089/end.2006.0375

Percutaneous Nephrolithotomy in the Supine Position: A Neglected Approach?

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ABSTRACT

***Purpose*: The aim of the study was to demonstrate the safety and effectiveness of single-stage percutaneous nephrolithotomy performed in the supine position.**

***Patients and Methods*: A single surgeon performed 322 consecutive percutaneous nephrolithotomies in patients in the supine position between 1999 and 2006, which were studied prospectively.**

***Results*: There were no complications related to the supine position, and in only one patient was there failed access. This patient's kidney was subsequently punctured with the patient in the supine position. There were no colonic injuries, no pneumothoraces, and a transfusion rate of 3.7%. Surgery on all patients with stones, including staghorn calculi and bilateral stones managed synchronously, was in the supine position. The median time to percutaneous access in a timed cohort of 27 patients was 5 minutes. The stone clearance rate was 91%. The median length of hospital stay was reduced from 6 days in the initial unstented patients to 3 days in the study overall when most patients received stents.**

***Conclusions*: Percutaneous nephrolithotomy in the supine position is safe, effective, and suitable for the majority of patients. It offers the potential advantages of better urethral access, less patient handling, and the need to only drape once, thus reducing the overall operative time compared to the traditional prone position.**

INTRODUCTION

DESPITE NEWER ADVANCES in stone surgery, including extracorporeal shockwave lithotripsy (SWL) and flexible ureteroscopy with laser lithotripsy, the percutaneous approach is still often the optimal method for minimally invasive upper-tract stone surgery. The prone position is potentially dangerous for patients who undergo general anesthesia, particularly those in poor condition, in those with severe cervical spondylosis, and in the obese. Care of pressure areas is problematic, respiratory compromise can occur, and cardiopulmonary resuscitation in the event of a cardiac arrest is difficult.

Percutaneous stone surgery performed in the supine position offers constant urethral access, involves less manual handling, and should be quicker and safer than surgery performed in the traditional prone position. We sought to demonstrate the safety and effectiveness of single-stage percutaneous stone surgery performed in the supine position in a prospective study.

PATIENTS AND METHODS

Results of 322 consecutive percutaneous nephrolithotomy (PCNL) procedures performed by a single surgeon (DS) from January 1999 to May 2006 were studied. The surgery was performed at two public hospitals and one private hospital. Patients were selected for percutaneous surgery if this was thought to be the preferred primary method of stone surgery or if other methods had failed.

SWL was often not available for more urgent surgery, and flexible ureteroscopy was unavailable at either of the public hospitals. For these reasons and because consecutive patients were studied, two patients with unusually small stones were included. These patients had mini-PCNLs for 3 mm and 4 mm stones that were impacted at the ureteropelvic junction after failed conservative management in a hospital without access to SWL or flexible ureteroscopy.

There were two patient exclusions: one woman with a large upper-pole stone before the availability of the holmium laser

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TABLE 1. PATIENT DETAILS

Sex	Male (n = 198)	Female (n = 124)	Total = 322
Age (years)	Min 19	Max 89	Median 58
Side	Left 170	Right 152	
Weight (kg)	Min 38	Max 153	Median 82
Weight	68 > 100 kg	23 > 120 kg	3 > 140 kg
Stone size	Min 3 mm	Max 80 mm	Median 15 mm

and a second woman with a large recurrent stone in a horseshoe kidney. These patients both had percutaneous surgery in the prone position.

All patients were evaluated preoperatively with noncontrast spiral CT scans. Patient age, side of stone, weight, stone characteristics, stent inclusion, hospital length of stay, and complications were recorded (Table 1).

Women were placed in the low lithotomy position to enable access to the urethra; a 3 L bag of saline was placed under the flank. Some men were placed in this position if concurrent rigid ureteroscopy or rigid cystoscopy was required for separate stone removal. Usually, however, men were placed in the supine position with a 3 L bag of saline under the flank (Fig. 1). After chlorhexidine 0.05% preparation of the perineum and flank, leggings were placed if the patient was in the modified lithotomy position. In all patients, a large disposable drape was attached to the flank and a hole cut for the penis or for access to the female urethra.

A flexible cystoscope was used to pass a hydrophilic-coated guide wire into the ureter, and an open-ended ureteral catheter was passed over this to allow injection of contrast. With the surgeon sitting, kidney puncture was performed in the posterior axillary line just above the saline bag, usually through a lower or mid-region calyx but sometimes through an upper-pole calyx, which often required a supracostal puncture. With the image intensifier overhead, the surgeon's hands were not irradiated, as they would have been in a prone-position puncture.

Either a stiff wire was manipulated down the ureter or the initial wire was passed to the bladder and brought out through the urethra and clamped. A tract was dilated using a balloon dilator leaving a 32F sheath or, in a mini-PCNL, a 20F peel-away sheath. Stones were fragmented using pneumatic lithotripsy or the holmium laser and extracted by rigid or flexible nephroscopy. Because the tract is horizontal or inclined slightly upward medially, stone fragments tend to fall out spontaneously, thus speeding stone clearance.

FIG. 1. When a patient is placed in the supine position for percutaneous nephrolithotomy, a 3 L bag of saline is positioned beneath the flank.

Stone clearance was determined by a combination of fluoroscopy and rigid and flexible nephroscopy at the end of the procedure, sometimes with a plain radiograph or CT postoperatively if there was not confidence in the intraoperative assessment. After stone removal, a ureteric stent was usually placed from above.

A straight or pigtail nephrostomy tube was sutured in place to accommodate drainage into a urostomy bag; a long-acting local anesthetic (20 mL bupivacaine HCL 0.5% or ropivacaine 0.75%) was infiltrated around the nephrostomy tube. A 16F urethral catheter was inserted.

If stone clearance was judged to be satisfactory, the nephrostomy tube was removed the next morning. The urethral catheter was removed the next day, and the patient was discharged. About 1 week later, the patient returned for flexible cystoscopy and stent removal. On some occasions, usually if a simple mini-PCNL was performed early in the day, the nephrostomy tube was removed the evening of surgery. If the patient was comfortable, afebrile, and there was no longer drainage from the nephrostomy site, discharge home the next day after just one night in hospital was achieved.

Access to upper-pole stones requiring supracostal upper-pole punctures is potentially more difficult but was achieved in the supine position as required. Because all patients had preoperative CT scans, the relationship of the kidney to the liver, spleen, and colon could be assessed, and there were no instances of damage to solid viscera or bowel. However, with flexible nephroscopes, tipless Nitinol stone baskets, and the holmium laser, we found supracostal access is rarely required; access is usually through the lower or mid-region calyces.

Thirty-three staghorn calculi were satisfactorily managed in patients in the supine position using single or multiple punctures. The approach was mainly through the lower pole with flexible nephroscopy and laser lithotripsy as required for areas that could not be reached with the rigid nephroscope.

RESULTS

Of the 322 patients, percutaneous access was achieved in all but one. A repeated procedure was successful at the second attempt, again with the patient in the supine position. In three patients, the stones were inaccessible at nephroscopy. The time from commencing flexible cystoscopy to achieving satisfactory

TABLE 2. RESULTS

Total PCNL's	322
Access in supine position	321
Mini-PCNL	25
Staghorn calculi	33
Total time taken	15–300 minutes
Bilateral synchronous PCNL's	17
Median time to access (27 patients)	5 mins (3–12)
Stone clearance	293 (91%)
Primary stenting	245 (76%)
Second look nephroscopy	8 (2.48%)
Length of stay (median)	1st 40 4 days (2—32) Last 40 3 days (1—11) Overall 3 days (1—38) >119 kg 4 days (2—38)

placement of a guide wire in the collecting system was recorded in 27 patients toward the end of the series, and the median time to access the collecting system was 5 minutes (range 3–12 min).

Complete clearance of significant stone fragments was achieved in 91% of patients (Table 2). Sometimes, simultaneous rigid ureteroscopy was performed for a ureteric calculus present at the same time as the renal calculus. Routine ureteral stenting was not initially undertaken, but after three urine leaks requiring secondary stents and prolonged hospitalization in the first five patients, routine stenting was undertaken unless a stent had been placed preoperatively The median length of hospital stay was reduced from 6 days in the initial unstented patients to 3 days in the series.

Patient weight ranged from 38 to 153 kg with a median of 82 kg. Twenty-three, patients weighed 120 kg or more and the median length of stay for those patients was 4 days compared with 3 days for other patients in the series. Body mass index is a better parameter, but patient heights were not recorded. Weight is a good indicator of patient size and shows that heavier patients were not excluded from the study and were still treated successfully.

Complications are shown in Table 3. One patient experienced deep venous thrombosis, and pulmonary emboli developed in another 40 hours postoperatively. The latter patient was a 73-year-old man who had a reasonably quick and apparently uncomplicated transpleural puncture above the twelfth rib for an upper-pole partial staghorn calculus.

Three patients had documented splits in the collecting system; they healed without further complications with a stent left in place for several weeks. Twelve patients (3.7%) required a transfusion, including one patient who required radiologic remobilization of a small branch of the renal artery.

DISCUSSION

Rupel and Brown[1] have been credited with the first percutaneous renal instrumentation when they passed a cystoscope down an openly placed nephrostomy tract in 1941. Fourteen years later, in 1955, Goodwin and associates[2] described percutaneous puncture of the kidney in the prone position to establish a nephrostomy. Twenty-one years later, Fernstrom and Johansson[3] described this approach to undertake the first percutaneous nephrolithotomy. In the late 1970s and early 1980s, Alken et al.,[4] Clayman,[5] and Das Gupta et al.[6] developed the clinical technique of percutaneous nephrolithotomy. While the original articles provide no rationale for the prone approach, nevertheless it became the standard approach for PCNL.

There had been concern that the supine approach may have put the colon at more risk of injury than the prone position. Boon and coworkers,[7] on the basis of studies of CTs, estimated a risk of colonic injury of 16%, but this has not been reflected in practice. Valdivia Uria and associates[8] first described the supine position for percutaneous stone surgery in 1998. Based on their CT studies, they suggested that rather than making the colon more vulnerable to injury, the colon floats away from the kidney when the patient is in the supine position; this makes the colon less likely to be injured by a puncture made in the posterior axillary line.

In all the published series, there have been no colonic injuries in 672 patients treated in the supine position and none in this series of 322. In the study by Reddy and colleagues,[9] there was one colonic injury in 400 patients, and in the study by Segura and coworkers,[10] two colonic injuries were reported in 1,000 patients. This may support the contention of Valdivia Uria and associates[8] that the colon is, in fact, less vulnerable when the patient is in the supine position.

Initially, percutaneous surgery was a staged procedure with the kidney puncture being performed by a radiologist under local anesthesia and sedation in the radiology department. In this circumstance, placing the patient in the prone position did not present any particular difficulties. One of the significant evolutions in the technique has been the widespread, though not universal, renal puncture by a urologist, making it a single-stage procedure (Lashley and Fuchs[11]). This now makes the prone position less attractive because of the need to reposition the patient.

Few studies have reported time to achieve access to the collecting system. In a subset of this patient population (20 consecutive patients), once the surgeon was familiar with the approach, the time to achieve access to the collecting system was a mean of 5.9 minutes. While not entirely similar, Allen and colleagues[12] reported that an experienced surgeon who had performed more than 1,600 PCNLs in patients in the prone position, had an average screening time of 3.5 minutes. This suggests that once experienced, the time to access the collecting system is not materially different for the two approaches, although time for position change has to be added to the prone approach.

Assessment of stone clearance varies in the literature. In this study, postoperative plain radiograph or CT was not routinely

TABLE 3. COMPLICATIONS

Failed access	1
Inaccessible stone	3
Bleeding requiring transfusion	12 (3.7%)
Bleeding requiring embolization	1
Delayed stenting for urine leak	3
Accidental antegrade stent removal	2
DVT	1
PE	1
Discharging sinus	1

used. Flexible nephroscopy was used very frequently, as it had been shown by Denstedt and coworkers[13] to be more sensitive than plain radiograph or CT. Pearle and associates[14] showed that spiral CT was 100% sensitive but only 62% specific and that routine second-look nephroscopy after positive results with CT could result in an unnecessary procedure and increased cost in a significant number of patients.

In this study, the stone clearance rate of 91% compares reasonably with other studies. In 1985, Reddy and colleagues[9] reported a 99% stone clearance rate in 400 patients, and Segura and coworkers[10] reported a 98.3% stone clearance rate in 1,000 patients undergoing PCNL in the prone position. In 2005, Osman and associates[15] reported results from 315 patients undergoing PCNL in the prone position; these patients had a stone clearance rate of 96.5%. With the trend over time for PCNL to be used for larger stones, one may have expected more difficulties and lower clearance rates, but this does not appear to be the case.

No data on stone clearance was presented by Uria and coworkers[5] in their PCNL series with patients in the supine position, but Shoma and colleagues[16] reported a prospective but nonrandomized study in which PCNL was performed in 53 patients in the supine position and in 77 patients in the prone position. The stone clearance rates were 89% (supine) and 84% (prone).

The potential disadvantages associated with the use of the supine position have been well documented by Shoma and colleagues.[16] The main concern was that the more lateral placement of the renal puncture would result in greater complication rates and compromise access to the renal collecting system and, hence, safe stone clearance. However, the puncture site at the posterior axillary line is not very lateral. Judging by scars, on some occasions in patients in our series, the puncture has been no more lateral than previous PCNLs performed on the same patient in the prone position. In the study by Shoma and associates,[16] there was no significant difference in the rates of stone clearance, bleeding, urinary leakage, and fever or in mean length of hospital stay between patients in the supine and prone positions.

Reddy and coworkers[9] reported bleeding in seven patients with an overall transfusion rate of 8%; a partial nephrectomy was performed in one patient, and hydrothorax developed in three patients. The average hospital stay for the first 300 patients was 7.9 days (range 3–21 days). For the last 100 patients, hospital stay was reduced to 3.5 days. Segura and colleagues[7] reported a 3% transfusion rate, one nephrectomy, and a mean hospital stay of 5.2 days. Osman and associates[15] reported no transfusions but an intervention rate of 0.3% for bleeding. These studies appear to be representative of the results that could be expected for PCNL.

Valdivia Uria and colleagues[8] reported severe bleeding on three occasions in patients in the supine position, resulting in one nephrectomy and transfusion in an additional five patients. Shoma and coworkers[16] reported a bleeding rate of 9% in patients in the supine position. Ng and colleagues[17] reported one nephrectomy performed for bleeding in 62 PCNLs performed in patients in the supine position.

Our transfusion rate of 3.7% with one radiologic embolization (0.3%) and no nephrectomies is comparable. In our series of 322 patients, the 3-day length of stay compares favorably and is, in part, because of routine ureteral stenting. Even without retained ureteral stone fragments, in some patients, leakage occurs from the nephrostomy site, presumably because of ureteral edema. This occurrence can delay discharge from hospital and possibly require secondary stenting. Routine ureteral stenting eliminated the nephrostomy site leaks and enabled earlier discharge in our study.

We also examined whether the supine approach was as effective for obese patients, because the prone position can add extra difficulties for these patients. Koo and colleagues[18] reported failed access in 10 of 79 patients with a body mass index >30. In this study, the body mass index was not available, but in 68 patients who weighed more than 100 kg, of whom 23 weighed in excess of 120 kg, access was achieved in all cases. In three patients, a larger flank incision was made with puncture from the deep fascia as described by Curtis and coworkers.[19]

From these results and the other three studies, it appears that the supine approach for PCNL has been neglected because of fears of safety and reduced efficacy. This study indicates that the supine approach appears to be as safe and effective as the prone position. It is important that a randomized trial be considered.

CONCLUSION

This study showed that the supine position for percutaneous stone surgery is safe and effective. A randomized trial is now required to determine if its potential advantages will make it preferable to the prone position for percutaneous stone surgery.

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ABBREVIATIONS USED

PCNL = percutaneous nephrolithotomy; SWL = shock-wave lithotripsy.