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ORIGINAL ARTICLE

Percutaneous nephrolithotomy in the supine position: Safety and outcomes in a single-centre experience

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ABBREVIATIONS

PCNL, percutaneous nephrolithotomy;
PCN, percutaneous nephrostomy;
BMI, body mass index

Abstract ***Objectives:*** To assess the feasibility of performing percutaneous nephrolithotomy (PCNL) with the patient supine. Although PCNL with the patient prone is the standard technique for treating large (> 2 cm) renal stones including staghorn stones, we evaluated the safety and efficacy of supine PCNL for managing large renal stones, with special attention to evaluating the complications.

Patients and method: In a prospective study between January 2010 and December 2011, 54 patients with large and staghorn renal stones underwent cystoscopy with a ureteric catheter inserted, followed by puncture of the collecting system while they were supine. Tract dilatation to 30 F was followed by nephroscopy, stone disintegration using pneumatic lithotripsy, and retrieval using a stone forceps. All patients had a nephrostomy tube placed at the end of the procedure. The results were compared with those from recent large series of supine PCNL.

Results: The median (range) operative duration was 130 (90–210) min, and the mean (SD) volume of irrigant was 22.2 (3.7) L. One puncture was used to enter the collecting system in 51 renal units (94%), while three units (6%) with a staghorn

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stone needed two punctures. The stone clearance rate was 91%, and five patients had an auxiliary procedure. There were complications in 15 patients (28%). All patients were stone-free at a 3-month follow-up.

Conclusion: Supine PCNL is technically feasible; it has several advantages to patients, urologists and anaesthesiologists. It gives stone-free rates and a low incidence of organ injury comparable to those in standard prone PCNL.

Introduction

The first documented percutaneous nephrostomy (PCN) was by Thomas Hillier in 1865, but it was not until 1955 when Goodwin et al. [1] reported their work on PCN for the drainage of suppuration and urine in a hydronephrotic kidney that PCN gained widespread acceptance. In 1976 Ferstrom and Johansson [2] reported the first percutaneous procedure for stone removal and since then percutaneous nephrolithotomy (PCNL) has been shown to be effective and safe for treating large renal stones (> 2 cm), including staghorn stones.

PCNL is usually done with the patient prone, as it is believed that for puncturing and dilatation of the kidney, which is a retroperitoneal organ, the posterior approach provides a large working space with a lower incidence of splanchnic and vascular injury. However, even in this position, major complications, including haemorrhage and organ injury, have been reported in 0.9–4.7% of cases [3,4]. The prone position is associated with patient discomfort, a compromised circulation and ventilation, especially in obese patients, and it is also time-consuming and increases the radiological hazards to the urologist [4].

Various modifications of patient positioning for PCNL were tried as urologists understood more of the surface anatomy of the kidney and related viscera. These included the reverse lithotomy [5], supine [6] and lateral decubitus [7] positions. These options were shown to be safe and effective compared with the conventional prone PCNL, yet were never popular. The complete supine PCNL is a tempting substitute for prone PCNL, with the potential advantages of less patient handling, a quicker operation, better drainage through the Amplatz sheath, and the ability to perform simultaneous PCNL and ureteroscopic procedures [6–8]. Although severe complications of anaesthesia are infrequently reported with the patient prone, the supine position is more comfortable for the anaesthetist, especially in obese patients at high-risk during anaesthesia [6].

Thus we assessed supine PCNL to evaluate its safety and efficacy in managing large renal stones, with special attention to evaluating the complications.

Patients and method

At our centre, between January 2010 and December 2011, supine PCNL was used in 54 patients (median age 39 years, range 19–62; 31 men and 23 women) with a median (range) body mass index (BMI) of 30 (17–42) kg/m^2.

The preoperative evaluation included history, clinical examination and routine laboratory investigations. All patients had IVU or noncontrast-enhanced spiral CT of the urinary tract to evaluate the stone location, burden and radiolucency. The stone burden was determined by measuring the longest diameter on the preoperative radiological investigations; if there were multiple calculi the burden was defined as the sum of the longest diameter of each stone.

A preoperative sterile urine culture was mandatory and patients with a positive culture were treated for 48 h before PCNL, and the treatment continued for 7 days afterwards. A third-generation cephalosporin was given as prophylaxis to patients with a sterile culture at the time of surgery, and was continued for 48 h afterwards. Staghorn stones included in the study were either one stone with branches from the renal pelvis into all major calyces, or a pelvic stone with multiple stones in at least two major calyceal groups. The median stone size was 20 mm, 12 patients had a staghorn stone, 10 had a pelvic stone, and 32 had multiple stones, with a mean stone burden of 29.7 mm (Table 1).

The procedure began with the patient in the lithotomy position, with insertion of an open-tip 7–8 F ureteric catheter, using a 22 F cystoscope. The operative duration was calculated from the time of ureteric catheter insertion until the nephrostomy tube was secured to the skin.

After inserting the ureteric catheter, the patient was placed supine with the ipsilateral arm secured to the chest, and a 3-L fluid bag under the flank. Under fluoroscopic guidance an 18 G needle was used to puncture the collecting system. Unlike in the prone position, the needle must remain almost horizontal or slightly inclined upward towards the operating table. We marked the puncture site, which lies at the level of the posterior axillary line under the level of the 12th rib, targeting the lower posterior calyces (Figs. 1 and 2).

Table 1 The perioperative variables of the 54 patients.

Variable	Value
Age (years)	
Median (range)	39 (19–62)
Mean (SD)	38.8 (14)
Sex, M/F (n)	31/23
Stone site, R/L (n)	28/26
Stone location (n)	
Pelvis	10
Pelvis + calyceal	32
Staghorn	12
BMI, kg/m^2	
Median (range)	30 (17–42)
Mean (SD)	30.2 (6.9)
Stone burden (mm)	
Median (range)	30 (10–55)
Mean (SD)	29.9 (10.9)
Stone radiolucency (n)	
Radio-opaque	37
Radiolucent	11
Mixed	6

Figure 1 The patient position.

Figure 2 The puncture site.

A 0.9 mm (0.038 inch) guidewire was inserted, followed by dilatation of the tract using PTFE dilators up to 12 F; this was followed by inserting a second (safety) guidewire. The tract was dilated up to 30 F using metallic telescopic dilators (Alkan's dilators), followed by the insertion of a 30 F Amplatz sheath.

The increased mobility of the kidney, due to the absence of support when supine, caused the guidewire to buckle, hindering tract dilatation. This was managed by an assistant supporting the patient's abdomen, pushing it backward during dilatation. After tract dilatation we used a 27 F nephroscope with a ballistic energy source for stone disintegration.

The volume of irrigant used and the duration of fluoroscopic exposure were recorded at the end of the procedure. Haemodynamic changes and any need for transfusion were evaluated and recorded during the first 24 h after surgery.

A radiological examination was used to assess stone clearance on the first day after surgery, with either a plain film of the abdomen or CT of the urinary tract. Perioperative complications were classified according to the modified Clavien grading system [9]: Grade 1, any deviation from the normal postoperative course but with no need for pharmacological, surgical, endoscopic, or radiological intervention; Grade 2, complications requiring pharmacological treatments or blood transfusions; Grade 3, complications requiring surgical, endoscopic, or radiological intervention with no (grade 3a) or with (grade 3b) general anaesthesia; Grade 4, life-threatening complications requiring a stay in an intensive care unit (grade 4a, single organ; grade 4b, multi-organ dysfunction); Grade 5, death.

Results

The median operative duration was 130 min, and the median duration of X-ray exposure was 10 min. The mean (SD) volume of irrigant fluid was 22.2 (3.7) L. One puncture was used to enter the collecting system in 51 renal units (94%), while three renal units (6%) with a staghorn stone needed two punctures.

We used a stone size of < 5 mm as the protocol for there being no need for further treatment. Of the 54 renal units treated, 49 had no or < 5 mm residual fragments, resulting in a stone-free (success) rate of 91%. Of the five renal units with residual stones, two were treated by a second supine PCNL through the already present nephrostomy tract, and these were rendered stone-free. One patient with a prolonged urine leak had his ureteric catheter changed for a double pigtail stent and had ESWL 2 weeks after discharge. The other two patients had ESWL with no stent for a calyceal residual stone. All patients were stone-free at a 3-month follow-up.

Any reduction in haemoglobin level, and the vital signs, were recorded; the mean (SD) reduction in haemoglobin level was 1 (1.15) g/dL, with two patients requiring a transfusion. In our practice we remove the nephrostomy tube 2 days after surgery, and in the absence of a urine leak and/or fever, we remove the ureteric catheter 24 h afterwards.

Table 2 Outcomes of the procedure.

Variable	Value
Operative duration (min)	
Median (range)	130 (90–210)
Mean (SD)	134.9 (29.3)
X-ray exposure (min)	
Median (range)	10 (4–19)
Mean (SD)	10.5 (4.7)
Access, n (%)	
Single	51 (94)
Multiple	3 (6)
Irrigant fluid (L)	
Median (range)	21 (18–33)
Mean (SD)	22.2 (3.6)
Stone clearance, *n* (%)	49 (91)
Auxiliary procedure, *n* (%)	5 (9)
2nd PCNL	2 (3.5)
JJ insertion + ESWL	1 (2)
ESWL	2 (3.5)
Complications, n (%)	
Grade 1	2 (4)
Grade 2	10 (19)
Grade 3	3 (5)
Total	15 (28)
Transfusion rate	2 (3.7)
Organ injury	0
Hospital stay (days)	
Median (range)	5 (3–8)
Mean (SD)	4.6 (1)

There were complications in 15 patients (28%); two had a persistent urine leak for > 24 h after nephrostomy removal (4%, grade 1) and they were managed conservatively. Ten patients (19%) had grade 2 complications, with eight having a fever of > 38 °C, who responded to antibiotics and antipyretics, and two had bleeding necessitating a blood transfusion (transfusion rate 3.7%). Three patients needed an auxiliary endoscopic procedure under anaesthesia (5% grade 3). There was no case of organ injury or fistula (urinary or vascular).

If there were no complications the patients were discharged on the same day that the urinary catheter was removed; the median (range) hospital stay was 5 (3–8) days. Patients were scheduled for a follow-up at 1 month and were assessed by urine culture, together with a plain abdominal film and/or CT of the urinary tract before the follow-up visit (Table 2).

Discussion

PCNL is widely accepted as the treatment of choice for large renal stones, including staghorn stones. It is less invasive, effective, safer and has a lower complication rate than open renal surgery [10]. PCNL is usually done with the patient prone, which carries several disadvantages to the patient, anaesthesiologist and urologist.

In 1987, Valdivia et al. [11] reported the first study on the feasibility of PCNL in the supine patient, but it was 1998 before the same authors reported their 10-year experience of PCNL with the patient supine [6], and that this technique was then reintroduced. The results were similarly good in several other reports [12–14], confirming the efficacy and safety of supine PCNL for treating most renal stones.

The supine position offers several advantages. General anaesthesia is less hazardous, no repositioning of the patient is needed, it is more comfortable for the surgeon, who can work while seated. The X-ray exposure to the surgeon during the entire procedure is decreased because the surgeon's hands are no longer in the fluoroscopic field and stone fragments are cleared easily.

In the present study PCNL was used in 54 patients; the median (range) and the mean (SD) BMI were 30 (17–42) and 30.2 (6.9) kg/m^2, respectively, denoting that most patients included in the study were overweight. The median (range) operative duration, including the time of ureteric catheter insertion, was 130 (90–210) min. Mean operative times of 85 and 98 min were reported by Valdivia et al. [6] and Falahatkar et al. [14], respectively (Table 3) [12]. Hoznek et al. [12] reported a mean (range) operative duration of 123 (50–245) min.

Puncturing the upper calyces with the patient supine is almost impossible, but staghorn stones were amenable to

Table 3 Evaluation of outcome in a series of supine PCNL for large stones.

Variable	Study				
	[12]	[15]	[14]	[6]	[16]
Renal units	47	53	117	557	39
Mean (range) stone Burden (mm)	29 (10–75)	NA	36 (10–80)	NA	34 (25–51)
Staghorn stones, *n* (%)	7 (14)	3 (5.6)	11 (9)	NA	0
Mean (range) operative Duration (min)	123.5 (50–245)	NA	98 (20–180)	85(15–240)	(25–120)
Stone-free rate, *n* (%)	38 (81)	47 (89)	91 (77.5)	NA	34 (88.7)
Transfusion rate, *n* (%)	1 (2)	5 (9)	17 (14)	8 (1.4)	0
Organ injury, *n* (%)	0	0	0	0	0
Hospital stay (days)	3.4 (2–12)	2.5	3.2 (1–7)	NA	4.3 (2.2–8.4)

NA, not available.

treatment during supine PCNL. The present study included 12 patients with staghorn stones (22%) for whom the median (range) stone burden was 30 (10–55) mm. Seven patients (14%) with a staghorn stone were included in the study of Hoznek et al. [12]. Falahatkar et al. [14] included 11 patients (9%) with a staghorn stone in their study (Table 3).

The stones were cleared in 49 (91%) of the present patients; this was a better rate than reported by Hoznek et al. [12] and Falahatkar et al. [14], who achieved a stone clearance rate of 81% and 77.5%, respectively. This might be because the stone burden in the present study was less than in the other two. Shoma et al. [15] found a stone clearance rate of 89% in their study that included 53 patients. A similar result was given by De Sio et al. [16], who reported a stone clearance rate of 88.7% in their study of 39 renal units.

There were complications in 15 of the present patients (28%), graded according to the Clavien system, but most of the complications were of grade I and II (23%). There was bleeding requiring a transfusion in only two patients. There had been concerns that the supine approach might put the colon at higher risk of injury than the prone approach, but we think that colonic injuries are potentially less frequent due to the more anterior displacement of the colon when the patient is supine, as described by Hopper et al. [17]. In the present series there were no colon injuries.

Several modifications of supine PCNL were tried, reproduced and evaluated [18], and all of them decrease the operative duration and X-ray exposure compared with the classic prone PCNL. They also allow a quick access to the airway in case of emergencies. However, they vary in the ease of puncture, tract dilatation, ability to make multiple tracts and the ability to combine simultaneous ureteroscopy.

In a meta-analysis of the supine vs. the prone PCNL [13], the incidence of colon injury in the prone position was estimated to be 0.2–0.5%. In that analysis only one colonic injury occurred during a supine PCNL. The rate of colonic injury in supine PCNL from comparative studies was ≈0.5%, similar to the rate in previous reports of prone PCNL. Supine PCNL does not increase the risk of colonic injury, which remains a relatively rare complication.

PCNL with the patient supine has some limitations. It decreases the filling of the collecting system, making it constantly collapsed, and thus nephroscopy tends to be more difficult. However, maintaining low pressures within the renal cavities might be important to decrease fluid absorption. Upper-pole calyceal puncture is impossible because the upper pole lies more medial and posterior, and is concealed deeply in the rib cage. Also, renal puncture in the supine position requires that the needle-pass lies horizontally, which in an upper calyceal puncture will strike into the calyceal neck, and not the infundibulum. There was anteromedial renal displacement during tract dilatation, rendering the procedure more difficult, and this was managed by supporting the kidney while creating the tract.

Twelve of the present patients had staghorn stones, although their stone burden was relatively low; all but one had no significant residual fragments, three needed multiple renal punctures, which were made easily. We think that these results indicate the feasibility of using supine PCNL for staghorn stones in properly selected patients.

In a recent review of the development of PCNL positions in the last 35 years [19], evaluating their safety, advantages and limitations, the authors concluded that there was no perfect position for PCNL, and that '*Urologists who perform PCNL should be familiar with the differences in the positions and be able to use the method appropriate for each patient*'.

The present study has several limitations; it included a relatively small sample, and although it included patients with staghorn stones, the stone burden was relatively low. This was a descriptive study lacking a comparative arm and was not randomised.

In conclusion, supine PCNL is technically feasible, has several potential advantages, especially in patients at high risk when under anaesthesia, and can be used to treat all stone sizes. There is no apparent added risk in using this technique, and the stone clearance and complication rates are within the accepted values cited previously for the standard prone PCNL.

Conflict of interest

No conflict of interest to declare.

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References

[1] Goodwin WE, Casey WC, Woolfe W. Percutaneous trocar (needle) nephrostomy in hydronephrosis. *JAMA* 1955;**157**:891.

[2] Ferstrom I, Johansson B. Percutaneous pyelolithotomy: a new extraction technique. *Scand J Urol Nephrol* 1976;**10**:257–9.

[3] Kim SC, Kuo RL, Lingeman JE. Percutaneous nephrolithotomy: an update. *Curr Opin Urol* 2003;**13**:235–41.

[4] Michel MS, Trojan L, Rassweiler JJ. Complications in percutaneous nephrolithotomy. *Eur Urol* 2007;**51**:899–906.

[5] Lehman T, Bagley DH. Reverse lithotomy. Modified prone position for simultaneous nephroscopic and ureteroscopic procedures in women. *Urology* 1998;**32**:529–31.

[6] Valdivia JG, Valle J, Lopez JA, Rodriguez SV, Navarro CM, Fabian MR, et al. Technique and complications of percutaneous nephroscopy: experience with 557 patients in the supine position. *J Urol* 1998;**160**:1975–8.

[7] Gofrit ON, Shapiro A, Donchin Y, Bloom AI, Shenfeld OZ, Landau EH, et al. Lateral decubitus position for percutaneous nephrolithotripsy in the morbidly obese or kyphotic patient. *J Endourol* 2002;**16**:383–6.

[8] Papatsoris A, Masood J, El-Husseiny T, Maan Z, Saunders P, Buchholz NP, et al. Improving patient positioning to reduce complications in prone percutaneous nephrolithotomy. *J Endourol* 2009;**23**:831–2.

[9] Tefekli A, Ali Karadag M, Tepeler K, Sari E, Berberoglu Y, Baykal M, et al. Classification of percutaneous nephrolithotomy complications using the modified Clavien grading system: looking for a standard. *Eur Urol* 2008;**53**:184–90.

[10] Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle JS, Wolf Jr JS, et al. AUA guideline on management of stag horn calculi: diagnosis and treatment recommendations. *J Urol* 2005;**173**:1991.

[11] Valdivia Uría JG, Lachares Santamaría E, Villarroya Rodríguez J, Taberner Llop J, Abril Baquero G, Aranda Lassa JM, et al. Percutaneous nephrolithectomy: simplified technique (preliminary report). *Arch Esp Urol* 1987;**40**:177–80.

[12] Hoznek A, Rode J, Ouzaid I, Faraj B, Kimuli M, de la Taille A, et al. Modified supine percutaneous nephrolithotomy for large kidney and ureteral stones. Technique and results. *Eur Urol* 2012;**61**:164–70.

[13] Wu P, Wang L, Wang K. Supine versus prone position in percutaneous nephrolithotomy for kidney calculi: a meta-analysis. *Int Urol Nephrol* 2011;**43**:67–77.

[14] Falahatkar S, Farzan A, Allahkhah A. Is complete supine percutaneous nephrolithotripsy feasible in all patients? *Urol Res* 2011;**39**:99–104.

[15] Shoma AM, Eraky I, El-Kenawy MR, El-Kappany HA. Percutaneous nephrolithotomy in the supine position. Technical aspects and functional outcome compared with the prone technique. *Urology* 2002;**60**:388–92.

[16] De Sio M, Autorino R, Quarto G, Calabrò F, Damiano R, Giugliano F, et al. Modified supine versus prone position in percutaneous nephrolithotomy for renal stones treatable with a single percutaneous access: a prospective randomized trial. *Eur Urol* 2008;**54**:196–202.

[17] Hopper KD, Sherman JL, Luethke JM, Ghaed N. The retrorenal colon in the supine and prone patient. *Radiology* 1987;**162**:443–6.

[18] Kumar P, Bach C, Kachrillas S, Papatsoris AG, Buchholz N, Masood J. Supine percutaneous nephrolithotomy (PCNL): 'in vogue' but in which position? *BJU Int*; 2012 May 7 [Epub ahead of print].

[19] Karaolides T, Moraitis K, Bach C, Masood J, Buchholz N. Positions for percutaneous nephrolithotomy. Thirty-five years of evolution. *Arab J Urol* 2012;**10**:307–16.