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ORIGINAL ARTICLE

Flank free modified supine position: A new modification for supine percutaneous nephrolithotomy

Esam A.E. Desoky *, Mohammed N. Allam, Mostafa K. Ammar, Khaled M. Abdelwahab, Diab A. Elsaid, Amr M. Fawzi, Ahmed A. Alayman, Ashraf M.S. Shahin, Hussein M. Kamel

Urology, Faculty of Medicine, Zagazig University, Zagazig, Egypt

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KEYWORDS

Urolithiasis;
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Position;
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ABBREVIATIONS

PCNL, percutaneous nephrolithotomy; FFMSP, flank-free modified supine position; BMI, body mass

Abstract ***Objectives:*** Percutaneous nephrolithotomy (PCNL) is the standard management for large and/or complex urolithiasis, but the standard patient position for PCNL is undecided. With the patient prone PCNL has several drawbacks, while when supine, as described previously, PCNL has mechanical limitations. We describe a modification that aims to overcome these limitations and provide easy access comparable to that in the prone position.

Patients and methods: This prospective study was carried out at the Urology Department, Zagazig University, Egypt, from October 2008 to March 2011, and included 78 patients (48 men and 30 women). First the patient was placed supine and then in the 'flank-free modified' supine position. The distance between the last rib and the iliac crest in the posterior axillary line was measured in both positions.

Results: The mean age of the patients was 40.8 years, the mean (SD) stone diameter was 3.4 (0.7) cm, the number of right/left stones was 34/44, and mean body mass index was 28.8 kg/m^2. The mean (SD) increase in the distance between the last rib

* Corresponding author. Tel.: +20 2101606, mobile: +20 0100088784.
E-mail address: prof_esam_desoky@yahoo.com (E.A.E. Desoky).

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index; KUB, abdominal plain film

and the iliac crest in the posterior axillary line in the flank free modified supine position vs. the previous supine position was 12 (0.8) mm.

Conclusion: The flank-free modified supine position increases the distance between the last rib and the iliac crest, and, together with the absence of a cushion under the flank, provides ample space for puncture, dilatation, multiple tracts and manoeuvrability of the system with the nephroscope.

Introduction

Mankind has been afflicted by urinary stone disease for millennia. The oldest renal stone was described by Shattock in 1950, in an Egyptian mummy in a tomb dating to ≈4400 BCE [1]. The first percutaneous renal instrumentation was reported in 1941 by Rupel and Brown [2], when they passed a cystoscope down an openly placed nephrostomy tract. Although the original article provides no rationale for the prone approach [3], percutaneous nephrolithotomy (PCNL) is traditionally performed with the patient prone [4].

The prone position provides several advantages, including a larger surface area for the puncture site, a wider space for instrument manipulation, unlimited instrument excursions and feasible multiple accesses. However, it has several disadvantages, including discomfort for the patient after surgery (because in the prone position, the patient's body is subjected to many pressure points throughout the procedure), a longer operative time, a more evident risk related to pressure points, and circulatory and ventilatory difficulties (especially in morbidly obese, kyphotic or debilitated patients) [5].

The supine position for percutaneous stone surgery was first described by Valdivia-Uria et al. in 1998 [6]. According to their CT studies, they suggested that the colon lifts away from the kidney when the patient is supine, which makes the colon less likely to be injured.

Also, the supine position has several advantages, including ease of patient positioning, more patient comfort, dependant Amplatz-sheath drainage and better control of the airways during the procedure [6]. Other advantages include reduced cardio-circulatory or ventilatory dysfunction, and a quicker operation. Moreover, the surgeon can comfortably sit during the operation, and X-ray exposure is reduced because puncture and dilatation of the nephrostomy tract are quite perpendicular to the body, and the operator's hands are outside the fluoroscopic field [7].

However, one of the main disadvantages of the supine position is the lack of enough space for a third tract if needed, limiting its usefulness for staghorn calculi [4]. For this reason we devised a modification to the supine position to overcome this obstacle, and this new position was termed the 'flank-free modified supine position' (FFMSP).

Patients and methods

This study was conducted in Urology Department, Zagazig University Hospitals, from October 2008 to March 2011, and included 78 patients (48 men, 30 women, mean age 40.8 years, mean body mass index, BMI, 28.8 kg/m^2). Patients included were those with an indication for PCNL; excluded were those with intrarenal anomalies, complete staghorn stones, a stone burden mainly in the upper calyx, uncorrectable bleeding disorders, a BMI of >40 kg/m^2, and pregnancy.

The preoperative evaluation included medical history-taking, physical examination, laboratory investigations, i.e. urine analysis, urine culture/sensitivity, complete blood count, coagulation profile, blood urea nitrogen and serum creatinine, and radiological investigations, i.e. an abdominal plain film (KUB), abdominal ultrasonography, IVU and non-contrast spiral CT. The last was used in four patients (5%) with borderline kidney function, 38 (49%) for a history of ipsilateral pyelolithotomy, two (3%) for a horseshoe kidney, 12 (26%) because the stones were radiolucent on KUB, and two (3%) due to an ipsilateral persistent nephrostogram (CT showed a middle ureteric stone that did not appear on KUB). A renal isotope scan was taken in four patients (5%) with borderline renal function in whom the total GFR of both kidneys was 20–30 mL/min.

In cases with a positive urine culture, an appropriate antibiotic was prescribed for 1 week and urine culture was repeated to document urine sterility before intervention. Informed consent was signed by all enrolled patients.

Operative technique

General anaesthesia was used for all patients, and fluoroscopy was used for imaging in all patients. While the patients were in the lithotomy position, cystoscopy was performed and a 6 F open-tip ureteric catheter was introduced, and fixed with plaster tape to the indwelling Foley catheter. After finishing the first stage, the patient was first placed supine as reported by Valdivia-Uria et al. [6] (Fig. 1) and then in the FFMSP (Fig. 2a,b). The distance between the last rib and the iliac crest in the posterior axillary line was measured in both positions. The patients were placed in the FFMSP

Figure 1 The original valdivia position [6].

by putting a suitable cushion (a 3-L water bag, or less according to body mass) under the ipsilateral shoulder, the ipsilateral arm was placed over the thorax, and the ipsilateral leg was extended and crossed over the flexed contralateral leg. Renal access was achieved through the posterior axillary line. A subcostal puncture was used in all patients. Coaxial dilators of the Alken type were used for tract dilatation. A 30 F Amplatz sheath was positioned, allowing the introduction of a 26 F nephroscope. A pneumatic lithotripsy device was used to fragment the stone, and the fragments were retrieved through the Amplatz sheath. At the end of the procedure, an 18–22 F nephrostomy catheter was inserted.

At 1 day after surgery, patients were assessed with ultrasonography, KUB, and antegrade pyelography to evaluate residual fragments and ureteric patency. Non-contrast CT was used to assess the stone-free rate in patients with radiolucent stones.

The nephrostomy tube was removed on the second day after surgery if there was no indication for a 'second look'. One day later, the urethral and ureteric catheters were removed. Prophylactic parenteral broad-spectrum antibiotics were continued after surgery until all tubes were removed. The outcome was considered as a cure (successful procedure) if the patient became stone-free or had residual fragments of <4 mm in diameter. Patients with residual stones were scheduled for either a 'second-look' or ESWL. The operative time (from the induction of anaesthesia to removal of endotracheal tube) was estimated and any operative complications or conflicts were recorded.

Results

The study included 78 patients with an indication for PCNL who all fulfilled the inclusion and exclusion criteria; 38 (49%) had a history of ipsilateral pyelolithotomy, 10 (13%) a history of ESWL, and four (5%) a history of PCNL. Urine analysis was used in all patients; pyuria was present in 38, for whom urine culture/sensitivity was assessed, and antibiotics were accordingly

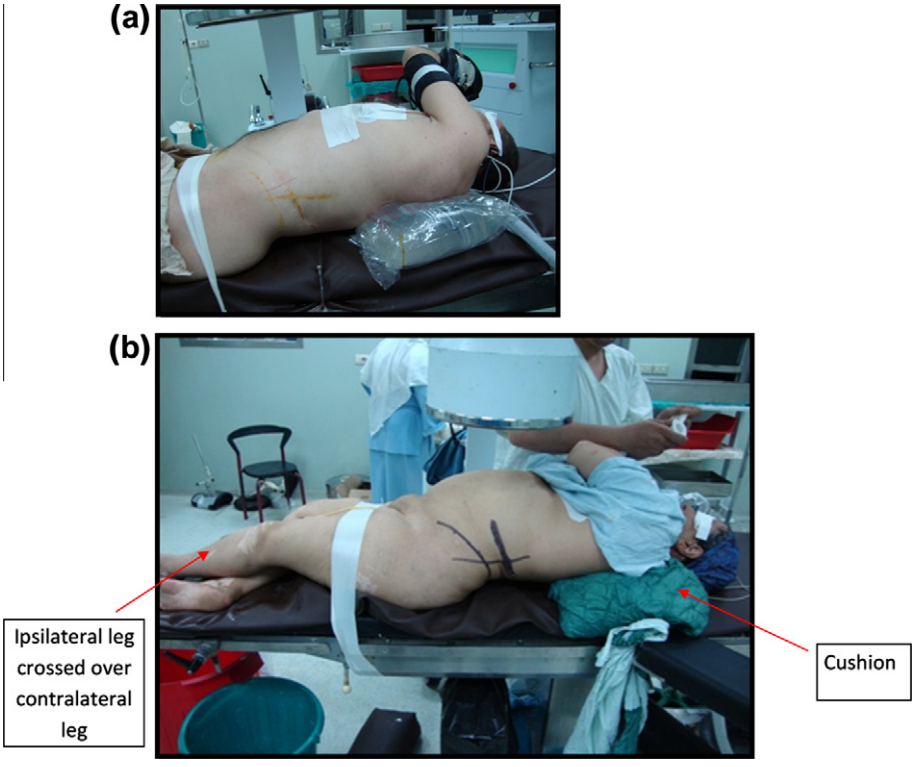

Figure 2 (a and b), The FFMSP.

Table 1 Stone characteristics.

Characteristic	*n* or *n*/*N*
Stone side (R/L)	34/44
Stone location	
Pelvis	30
Calyces	14
Both	34
Mean (SD) stone diameter (cm)	3.4 (0.7)
Stone opacity (radio-opaque/radiolucent)	66/12
Concomitant:	
ipsilateral lower ureteric stones	2
contralateral lower ureteric stones	4
contralateral renal and upper ureteric stones	6

Table 2 Complications (Grade according to the modified Clavien system).

Complication	*N* (%) of patients
Perforation of renal pelvis (Grade 3a)	2 (3)
Bleeding necessitated blood transfusion (Grade 2)	6 (8)
Urinary leakage (1 week after) (Grade 3a)	4 (5)
After 1st session	2
After 2nd look	2
Fever (38 °C) (Grade 2)	10
Colonic injury (Grade 4a)	0
Pleural injury	0
Urinoma	0
Delayed haematuria	0

prescribed for 1 week. Urine cultures were repeated to document sterile urine. The complete blood count and coagulation profile were within normal limits for all patients. Blood urea nitrogen and serum creatinine levels were within normal limits in 74 patients (95%), while in four (5%) they were borderline (serum creatinine 2–3 mg/dL).

IVU was used in 54 patients (69%), and pelvi-abdominal CT (with no intravenous contrast medium, but with delineation of the colon by oral contrast medium) in 58 (74%), as described above. The stone characteristics are shown in Table 1. In patients with concomitant ipsilateral or contralateral lower ureteric stones, ureteroscopy was performed first. Patients with contralateral renal and upper ureteric stones were stented (using JJ stents) before ESWL.

The mean (SD) increase in the distance between the last rib and the iliac crest in the posterior axillary line in the FFMSP vs. the Valdivia position was 12 (0.8) mm.

The lower calyx was punctured in 54 patients (69%), the middle calyx in 12 (15%), the combined lower and middle calyces in 10 (13%), and the upper calyx in a horseshoe kidney in two (3%). The posterior calyx alone was punctured in 70 patients (90%), the anterior calyx alone in two (3%) for a stone in the lower anterior calyx. Both the posterior and anterior calyces were punctured in six patients (8%) for stones present in the lower anterior and posterior calyces.

The mean hospital stay was 4.2 days. A 'second look' (for residual stones of $\geqslant$4 mm) was used in eight patients (10%), in whom a second subcostal puncture was needed in four (5%).

ESWL was used in four (5%) patients with residual stones of $\geqslant$4 mm in an inaccessible calyx. Two patients (3%) with a residual stone of 8 mm in the upper calyx passed the stone spontaneously before ESWL. All patients who had a 'second look' became stone-free or had residual stones of $<$4 mm, while patients who had ESWL became stone-free at 2 weeks after one session.

Complications related to the procedure are shown in Table 2. For patients who had a renal pelvis perforated, a JJ stent was placed. Postoperative fever that required additional antibiotics (instead of prophylactics) resolved with conservative measures (fluid, antibiotics and antipyretics). There was urinary leakage (1 week after surgery) in four patients (5%), in two cases due to a residual stone (4 mm) which was impacted in the intramural ureter after removing the ureteric catheter; those patients were treated by ureteroscopy, a JJ stent was placed and then removed 3 weeks later. For the other two patients in whom prolonged urinary leakage occurred after a second look, a JJ was placed and removed 3 weeks later.

Discussion

PCNL has been confirmed as effective and has stood the test of time compared to open stone surgery and ESWL [8]. PCNL has developed significantly during the last three decades due to improvements in access technique, instrumentation and lithotripsy technology [9].

For many years, the prone position was considered the only patient position for PCNL. It provides safe access to the kidney, a wide surgical field, adequate instrument manipulation, and a good distension of the collecting system. Nevertheless, some potential anaesthesiological complications (directly correlated with the position, including circulatory and ventilatory difficulties), especially in obese patients, and the intraoperative change of the position, represent the most important disadvantages of the prone position [6].

To overcome the obstacles of the prone position several modifications have been reported, including the prone split-leg position, reverse lithotomy position, and lateral decubitus, but most of these have fallen out of favour [10–12].

After the description by Valdivia-Uria et al. [6], supine PCNL has not gained wide acceptance in the urological community. A plausible reason for this is the surgeons' reluctance to use new techniques once a high efficacy and acceptably low morbidity were achieved with the conventional prone PCNL [9].

Published series from different centres show that supine PCNL is safe, and has several benefits for the

patient and several technical advantages for the surgeon [9,13,14]. The supine position offers several advantages. It is less time-consuming, more comfortable for the patient (which might enable the use of fewer anaesthetics), has more rapid access to the airway and therefore might be less hazardous, especially in patients with compromised cardiopulmonary function or morbid obesity, or in those who require a prolonged procedure. Also, if required, the supine position allows combined PCNL and ureteroscopy for managing complex stone disease [13].

The supine position offers several technical advantages for the surgeon. Because the tract is slightly inclined downward the spontaneous evacuation of stone fragments is facilitated. The more descendent position of the calyx in relation to the renal pelvis minimises the possibility of a stone fragment migrating into the ureter during stone fragmentation. Urologists are more comfortable if seated during stone management procedures [9].

However, and despite these merits, the supine position has not become popular. This might be attributed to limited freedom in manipulating the access site and the stone with a 3-L water bag under the flank, as described by Valdivia-Uria et al. [6]. The modification used here, by putting a suitable cushion (3-L water bag or less according to body mass) under the ipsilateral shoulder instead of under the flank, and extending the ipsilateral leg over the flexed contralateral leg increased the distance between the last rib and iliac crest, which together with absence of a cushion under the flank provided ample space for puncture, dilatation and manipulation of the stone. We aimed first to establish the technique, and the preliminary goal for increasing the distance between the last rib and the iliac crest was to facilitate manoeuvrability of the nephroscope, which was much hindered in the original Valdivia position. In further and future studies we will apply this technique to staghorn stones (which were excluded in the present study) for which multiple punctures can be applied.

In our study a subcostal puncture was used for all patients. There was no need for a supracostal puncture because complete staghorn stones and cases with a stone burden mainly in the upper calyx were excluded. In other published studies in which staghorn stones were included, a supracostal puncture was used in some patients [9,14].

The most common calyx punctured was the lower posterior calyx, while Valdivia-Uria et al. [6] chose to access the kidney through the anterior calyx. We think that the cushion under the flank, as described by Valdivia-Uria et al., causes technical difficulties when accessing the posterior calyx. Placing the cushion under the shoulder provides ample free space under the flank, so we could access the posterior calyx easily.

Middle or both lower and middle calyceal punctures were used in some patients, according to stone site. A U-shaped tract (Fig. 3) was used in 14 patients (18%). A subcostal upper calyceal puncture was used for stones in a horseshoe kidney in two patients (3%). A posterior calyceal puncture was preferred to limit bleeding, as reported previously by others [7,9,14]. However, Valdivia-Uria et al. [6] preferred the anterior calyceal puncture (possibly due to the cushion under the flank, which hindered the deflection of the nephroscope used to reach the anterior calyx through the posterior calyx). This obstacle was not obvious in the current study because the flank was free.

Methods for assessing the stone-free rate vary among reviewed studies. Nephroscopy, non-contrast CT, plain radiography, and ultrasonography are all mentioned [15]. In the present study ultrasonography was used routinely after surgery in all cases to identify the presence of any extravasation, and simultaneously any residual stones which were confirmed later on follow-up by plain radiography for radio-opaque stones and non-contrast spiral CT for radiolucent stones. Spiral CT was not used in all cases, to reduce the cost.

In the present study the success rate of the procedure was high; the stone-free rate was 82%, similar to the average of other published series of PCNL using either the prone or supine position. In their study, De Sio et al. [7] reported that the stone-free rate was good in both groups of PCNL using either supine or prone positions (88.7% vs. 91.6%, respectively). Shoma et al. [14]

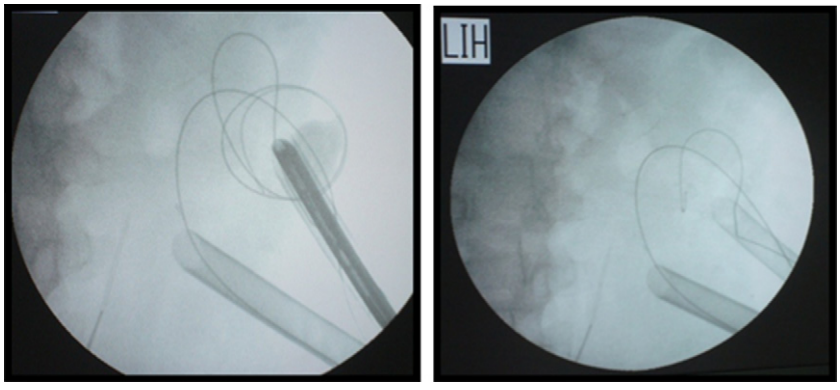

Figure 3 The U-shaped tract.

reported similar results for both positions (89% vs. 84%, respectively). Falahatkar et al. [13] reported lower stone-free rates for both positions (77.5% vs. 80%, respectively), as did Amon-Sesmero et al. [16], at 76% vs. 74%, respectively. The complication rate related to our procedure was comparable to that in other studies.

In conclusion, the FFMSP increases the distance between the last rib and the iliac crest, which together with the absence of a cushion under the flank, provides ample space for puncture, dilatation, multiple tracts and manoeuvrability of the system with the nephroscope.

Conflict of interest

The authors have no conflict of interest to declare.

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