



STONES/ENDOUROLOGY
ORIGINAL ARTICLE

Percutaneous nephrolithotomy in complete supine flank-free position in comparison to prone position: A single-centre experience



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KEYWORDS

Renal stone;
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Prone position;
Tubeless PCNL

ABBREVIATIONS

BMI, body mass index;
GMSV, Galdakao-modified supine Valdivia (position);
PCNL, percutaneous nephrolithotomy;

Abstract Objectives: To assess the outcomes of performing percutaneous nephrolithotomy (PCNL) in a modified supine position, more feasible for surgeons, anaesthetists, and operating theatre staff, as well as for the patient himself, and evaluating it in comparison to the standard prone position.

Patient and methods: A retrospective, case-control study was conducted between January 2011 and December 2015. In all, 197 patient's records were reviewed. The initial 101 patients were operated upon in prone position. From mid-2013, 96 patients were operated upon in a complete supine, flank-free position. The groups were compared in terms of operation time, calculated from positioning the patient after anaesthesia induction, insertion of ureteric catheter, puncture of renal system, until the end of procedure; stone-free rate; hospital stay; and postoperative complications, such as transfusion rate, fever, and urinary leakage.

Results: There were two significant differences between the groups. Firstly, the operation time was a mean (SD) 32.3 (6.6) min shorter for the supine versus the prone position ($P < 0.001$). Secondly, hospital stay was a mean (SD) 1.2 (0.75) days shorter for the supine vs the prone position ($P < 0.001$). The complete stone clear-

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RIRS, retrograde intrarenal surgery

ance rate (85.4% for supine vs 79.2% for prone; $P = 0.2$) and postoperative complications (7.3% for supine vs 17.8% for prone; $P = 0.02$) were comparable in both groups.

Conclusion: Supine PCNL is a feasible procedure with similar outcomes in terms of stone-free rate as well as postoperative complications, to the standard prone PCNL. It reduces unnecessary delay that occurs during change of position resulting in significant shortening of the total operation time and surgeons can perform supine PCNL whilst sitting.

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Introduction

The first percutaneous nephrolithotomy (PCNL), described by Fernström and Johansson [1] in 1976, was performed in prone position and was adopted as the standard technique for renal stones of > 20 mm. Although there are various advantages of performing PCNL in a prone position there are also disadvantages. Classically the patient is initially placed in the lithotomy position for ureteric catheter insertion and then changed to a prone position for the rest of the procedure. This changing of position under anaesthesia causes unnecessary delay and also a risk of nerves, limbs, neck, and ophthalmic injuries to the patient. Furthermore, this position is less favourable in morbidly obese patients and patients with severe cardiopulmonary diseases [2] and this led urologists to propose alternative positions for PCNL.

Valdivia et al. [3] first described PCNL in a supine position. This position did not gain in popularity for many years until Ibarluzea et al. [4] improved it further by adding a modified lithotomy arrangement, giving origin to the Galdakao-modified supine Valdivia (GMSV) position. Many authors suggested this position as being more safe and feasible with many advantages over the prone position in terms of reducing operation time, avoiding injuries that may occur during repositioning the patient, anaesthesia-related complications, as well as reducing radiation exposure to the surgeon, and ability of the surgeon to perform the procedure whilst sitting [5]. The major disadvantage of this position is limited exposure of the flank for renal puncture. Kumar et al. [6] made a slight modification by keeping the flank free for better exposure. Falahatkar et al. [7] performed PCNL in a complete supine position without any rolled towel or any change in leg position describing it as a safer and feasible position.

In the present study, we aimed to compare the outcomes of our modified supine position 'complete supine flank-free position', suggested by our colleague A.A. (author), to the standard prone position in terms of operation time, stone-free rate, hospital stay, and postoperative complications, such as blood loss requiring

transfusion, fever, and urine leakage from the surgical tract.

Patients and methods

We reviewed the records of all patients who underwent PCNL for the stone disease from January 2011 until December 2015. We performed 101 cases of PCNL in the standard prone position until mid-2013, after which all cases were operated upon in the complete supine flank-free position, as suggested by A.A.

Preoperative preparation

Patients included had an age range of 18–69 years and a body mass index (BMI) range of 15–47 kg/m². Stone size was measured by the total size in the longest diameter, or the collective sum of the longest diameter in cases of multiple stones. All patients were assessed preoperatively with history, physical examination, routine laboratory tests, and a negative urine culture was obtained. All patients had non-contrast CT of the renal tract preoperatively for evaluating the stone size and location, and the renal tract and its relation to adjacent viscera.

Technique

Patients in the prone group were initially kept in a lithotomy position for ureteric catheter insertion. Then the position changed to prone for fluoroscopic-guided puncture of the renal system and the rest of the procedure. All patients operated upon in the prone position routinely had 24-F nephrostomy tube and either a ureteric catheter or JJ-stent insertion.

Since mid-2013, all PCNL cases have been operated upon in a supine position with a slight modification to achieve the complete supine flank-free position. We placed our patients completely supine with two silicone gel pads, one under the ipsilateral chest and another under the buttocks, thus tilting the patient to 15°. The flank at the site of surgery was brought to the edge of the operating table to avoid the overlapping of X-rays



Figure 1 Complete supine flank-free position.

with the table. This gives a wider field for renal puncture. The ipsilateral leg was placed straight with a cushion under the knee to avoid stretch. The contralateral leg was placed in an abducted and flexed position over the table. This positioning allows simultaneous use of antegrade and retrograde renal access (Fig. 1).

The ureteric catheter is inserted using a flexible cystoscope. We used occlusive catheters to avoid migration of the stones in the ureter. Kidney puncture was performed under fluoroscopy guidance, followed by balloon dilatation of the tract and insertion of a 30-F Amplatz sheath. We prefer to use a 26-F nephroscope with an ultrasonic LithoClast® (Swiss Lithoclast from EMS) lithotripter for stone fragmentation. If necessary, simultaneous retrograde intrarenal surgery (RIRS) was used to reach the calyces that were not accessible through the nephrostomy tract, fragmenting the stone with the use of a holmium laser (Lumenis Pulse 120H, Israel) to a size that could be caught in a Dormia basket and brought to the renal pelvis and removed through the nephrostomy tract. Amongst 96 patients, only four needed simultaneous RIRS. The stone-clearance rate was confirmed by on-table X-ray. Non-contrast CT or ultrasonography was used at follow-up visits to assess the final stone-clearance rate. Patients that underwent supine PCNL had either ureteric catheter or JJ-stent insertion at the end of the procedure. Depending on procedure time, intraoperative haemorrhage, stone burden, or injury to pelvicalyceal system, a decision was made to keep the JJ stent either with the string or without it, for the ease of removing it 2–3 days postoperatively in the clinic without the need for any cystoscopy or anaesthesia. In similar way a decision for nephrostomy tube insertion

was made considering the above mentioned conditions. Most of the patients operated upon in the supine position had tubeless PCNL.

Follow-up

Patients were followed up after 1–3 months in clinic and were assessed by a plain abdominal X-ray, and/or CT of the urinary tract for any residual stone. Based on follow-up imaging the final stone-free status of the patient or the need for further treatment was confirmed.

Results

Amongst 197 patients, 101 were operated upon in a prone position. The mean (SD, range) age of the patients in the prone group was 45.2 (9.5, 24–69) years and in the 96 patients operated upon in the modified supine position was 38.9 (10.1, 18–68) years. Only nine patients (8.9%) in the prone group and 10 (10.4%) in the supine group were female. The mean (SD, range) stone size was 29.7 (15.10, 15–80) mm in the prone group and 29.9 (12.6, 15–70) mm in the supine group.

The mean (SD, range) operation time was 130.5 (40.90, 75–250) min for prone PCNL and 98.2 (34.3, 30–200) min for supine PCNL.

Of the 96 patients in the supine group, 53 (55.2%) did not have any nephrostomy drainage postoperatively, i.e. tubeless PCNL. All of the tubeless PCNL patients had either a JJ stent with a string or ureteric catheter/JJ stent without a string placed intraoperatively. Whereas all patients in the prone group had postoperative nephrostomy drainage fixed. Ureteric drainage in this position

Table 1 The patients' demographic, operative and postoperative data.

Variable	Supine PCNL	Prone PCNL	P
<i>Demographics</i>			
Number of patients	96	101	
Male, n (%)	86 (89.6)	92 (91.1)	0.7
Female, n (%)	10 (10.4)	9 (8.9)	0.7
Mean (SD, range)			
Age, years	38.9 (10.1, 18–68)	45.2 (9.5, 24–69)	
BMI, kg/m ²	27.9 (7.2, 15.4–45.1)	28.7 (6.5, 19.5–47.2)	0.4
Stone size, mm	29.9 (12.6, 15–70)	29.7 (15.1, 15–80)	0.5
<i>Results</i>			
Operation time, min, mean (SD, range)	98.2 (34.3, 30–200)	130.5 (40.9, 75–250)	<0.001
N (%)			
Stone-free rate	82 (85.4)	80 (79.2)	0.2
Residual fragment < 5 mm	4 (4.2)	3 (2.97)	0.6
Success rate	86 (89.6)	83(82.2)	0.14
Postoperative complications	7 (7.3)	18 (17.8)	0.02
Urinary leakage	5 (5.2)	14 (13.9)	0.04
Fever	2 (2.1)	1 (1)	0.5
Blood transfusion	–	3 (2.9)	0.09
Tubeless procedure	53 (55.2)	–	
Mean (SD)			
Hospital stay, days	2.7 (1.05)	3.9 (1.8)	<0.001
Nephrostomy	2.97 (1.2)	–	
No nephrostomy	2.4 (0.6)	–	

was done either by ureteric catheter or a JJ stent without a string.

Residual stones of < 5 mm were considered insignificant and did not need any further treatment. Of the 101 cases treated in the prone position, 80 patients (79.2%) had complete stone clearance and three patients (2.97%) had residual fragments of < 5 mm, resulting in a success rate of 82.2%. Of the remaining 18 patients (17.8%) with residual stones, six (5.9%) were treated with a second prone PCNL at later dates. These patients had either multiple renal stones or staghorn stones, initially with sizes ranging from 60–80 mm. Six patients (5.9%) had residual stones of < 10 mm and were treated with flexible ureteroscopy after a few weeks. Two patients (1.9%) underwent ESWL and four (3.9%) were lost to follow-up.

Of the 96 patients in the supine group, 82 (85.4%) had complete stone clearance, with four (4.2%) having residual fragments of < 5 mm, thus a resultant success rate of 89.6%. In all, 10 patients (10.4%) had residual stones of > 5 mm. One patient (1.04%) needed a redo PCNL during the same admission on his second postoperative day and was rendered stone free. Six patients (6.25%) had residual stones of ≤10 mm and they underwent flexible ureteroscopy and complete stone clearance was achieved. The remaining two patients (2.1%) were lost to follow-up. All patients were stone-free at the follow-up visit at 1–3 months after treatment.

In the prone group, 18 patients (17.8%) developed complications: 14 (13.9%) had a persistent urine leak

at 3 days postoperatively, five (4.9%) were managed conservatively (Grade I) and nine (8.9%) had to be stented either antegradely under fluoroscopic guidance in radiology suite or retrogradely under anaesthesia (Grade III). One patient (1%) had a fever > 38 °C, treated with antibiotics and three patients (2.9%) had bleeding necessitating blood transfusion (Grade II). Whilst in the supine group, seven patients (7.3%) developed complications: five (5.2%) had persistent urinary leakage 3 days postoperatively and amongst them, three (3.1%) were managed conservatively (Grade I) and two (2.1%) had retrograde JJ-stent insertion under anaesthesia (Grade III). Two patients (2.1%) had a fever of > 38 °C, treated with antibiotics and one patient (1.04%) was re-admitted with haematuria 2 weeks after surgery and was managed conservatively with antibiotics (Grade II). There were no severe complications, e.g. pneumothorax, arteriovenous fistula, adjacent visceral injury, or death in either group (Table 1).

The mean (SD, range) hospital stay was 3.9 (1.8, 2–8) days in the prone group and 2.7 (1.05, 2–5) days in the supine group. We further divided the supine group hospital stay into those with and without nephrostomy drainage, at a mean (SD) of 2.97 (1.2) days and 2.4 (0.6) days, respectively (Table 1).

Discussion

Most surgeons now prefer PCNL as the procedure of choice for large renal stones, including the staghorn

stones. For many years it was performed only in a prone position. Valdivia et al. [8] reported the first study on the feasibility of PCNL in a supine position in 1987, but this position did not gain in popularity until Ibarlueza et al. [5] described the GMSV position in 2007. This position allowed simultaneous antegrade and retrograde access to the urinary tract. After introduction of this position several other authors published studies [5,7,9,10] confirming the efficacy and safety of supine PCNL for treating most renal stones. The Barts flank-free modified supine position made further modifications allowing a wider field for percutaneous access [6].

The supine position can be considered as less time-consuming and more comfortable for patients and anaesthetists, as well as surgeons. The chances of accidental airway slippage and trauma to the nerves, limbs, neck and spine that can occur whilst changing a patient's position are reduced. Furthermore, for patients with compromised cardiopulmonary functions, morbidly obese patients or those who require a prolonged procedure, the supine position is thought more suitable [2]. The surgeon can perform this procedure whilst sitting with less exposure to radiation, as his hands remain far from the surgical field.

Supine PCNL went through many phases of evolution to improve its effectiveness. Although, even these modifications to supine PCNL also have some disadvantages [6]. For instance, in a complete supine position, the puncture space is limited. The patient has to be kept in lithotomy position for insertion of the ureteric catheter and simultaneous retrograde transurethral surgery cannot be performed. Also, the puncture space is limited due to presence of a cushion under the flank in the GMSV. Also, the kidneys are more mobile making tract dilatation more difficult [5]. Some of these difficulties were addressed and modified by Kumar et al. [6] in their Barts flank-free modified supine position with the legs kept in lithotomy, which is different from our present position. Desoky et al. [11] described a supine position that is almost the same as our present position, with a slight difference in the positioning of the legs. The major difference of their study compared to our present study was that they started the procedure by positioning the patient in lithotomy and then changing to a supine position.

In our present study, the mean BMI was $> 27 \text{ kg/m}^2$ in both groups, at a mean (SD) of $28.7 (6.5) \text{ kg/m}^2$, showing that most of the patients included were overweight. Therefore, theoretically supine PCNL should be the position of choice to overcome anaesthetic and ventilation difficulties in these patients. The mean (SD) operation time was $32.3 (6.6) \text{ min}$ less in the supine group compared with the prone PCNL group. Stones of $> 30 \text{ mm}$ or multiple stones in different calyces needed more time compared to single and smaller stones. This result shows a significant reduction in

operation time in the supine group ($P < 0.001$). It is important here to mention that in our present study, we calculated the operation time after the patients were anaesthetised, including the time taken in positioning as well as insertion of the ureteric catheter, until the end of the procedure. These results are comparable to the results published by Hoznek et al. [5] who reported a mean (SD, range) operative duration of $123.5 (51.2, 50\text{--}245) \text{ min}$ and Liu et al. [12] in their meta-analysis reporting an average of a 24.8 min reduction in operation time in a supine position.

We never access the renal system through a puncture in the upper calyx, as we find that the upper calyx can be easily approached by lower calyx puncture in the supine position, which has also been observed by Sofer et al. [13]. In our present study, the mean (SD, range) stone size in the prone and supine groups was $29.7 (15.1, 15\text{--}80) \text{ mm}$ and $29.9 (12.6, 15\text{--}70) \text{ mm}$ respectively, whilst the success rate was 82.2% in the prone group and 89.6% in the supine group. This is a better success rate than that reported by Hoznek et al. [5], who achieved a stone clearance rate of 81% . In a global study by the Clinical Research Office of the Endourology Society, Valdivia et al. [14] reported a stone-free rate of 77% in cases of prone vs 70.2% in supine positioned patients. Thus, our present study showed a better rate of stone clearance in the supine position, and comparable to the reported stone-free rates of Shoma et al. [15] and De Sio et al. [16] of 89% and 88.7% , respectively.

We graded the complications according to the Clavien–Dindo classification system. Only 8.9% (eight) of the prone PCNL patients and 2.1% (two) of the supine PCNL patients had Grade III complications, and were managed by JJ-stent insertion. None of our present patients had any serious complications graded IV or V. Bleeding requiring transfusion was comparable to other studies, which report a postoperative blood transfusion rate of $1.5\text{--}9\%$ [16,17]. Some studies have shown an even lower risk of bleeding in supine PCNL compared to prone PCNL [18]. No patient in either group developed severe sepsis. The slightly better outcome in the supine PCNL group for complications is probably explained by the easy and straightforward puncture leading to less bleeding and renal damage during tract dilatation and manipulation [19]. There were no cases of adjacent visceral injury in either group, whilst Duty et al. [20] reported a lower risk of visceral injury in the supine position. Wu et al. [9] in a meta-analysis of supine vs prone PCNL, reported a $0.2\text{--}0.5\%$ incidence of colon injury in the supine position, similar to the rate in previous reports of prone PCNL.

The other significant difference which we noticed in our present study was hospital stay, which was a mean (SD) of $1.2 (0.75) \text{ days}$ shorter in the supine group vs the prone group ($P < 0.001$). We thought this difference might be due to the fact that in 53 patients (55.2%) in

the supine PCNL group we did not insert a nephrostomy tube for drainage. So we calculated the hospital stay in patients without nephrostomy drainage vs those who had nephrostomy drainage, but there was an insignificant difference in hospital stay in both subgroups, at a mean (SD) of 2.4 (0.6) days without nephrostomy drainage and 2.97 (1.2) days with nephrostomy drainage ($P = 0.9$). Thus, the reduction in hospital stay appears to be independent of the presence or absence of nephrostomy drainage. The decision of either inserting a nephrostomy tube for postoperative drainage or not, or the placement of a type of ureteric drainage was based on operation time, intraoperative bleeding, residual stone or any pelvicalyceal injury during the procedure. Several studies have described that patients who underwent tubeless PCNL had significantly shorter hospital stays in comparison to those who had a nephrostomy tube inserted at the end of procedure [21].

In conclusion, supine PCNL is technically feasible and has several potential advantages. It can be used to treat all stone sizes and there is no apparent added risk in using this technique. The stone clearance and complication rates are comparable to the standard prone PCNL. It significantly decreases the total operation time. Due to the straightforward renal puncture leading to minimal bleeding and lesser trauma to the kidney, tubeless PCNL is a reasonable option in this position.

Conflict of interests

There is no conflict of interest for any author.

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