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Original Article

Surgery Section

Percutaneous Nephrolithotomy in Supine versus Prone Position in Tertiary Hospital in Mysore: A Prospective Cohort Study

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ABSTRACT

Introduction: Percutaneous Nephrolithotomy (PCNL) is a procedure of choice for large renal calculi. It is a common urological procedure. PCNL can be performed in various positions.

Aim: To determine the surgical outcomes in patients undergoing PCNL in supine and prone positions.

Materials and Methods: A cohort study was conducted on patients with renal and upper ureteral stones who underwent PCNL in either prone or supine position between August 2019 to August 2020 at Urology Department, JSS Hospital, Mysuru. Supine PCNL was done in the flank Free Oblique Supine Modified Lithotomy (FOSML) position. All the procedures were performed under fluoroscopy guidance. Surgical outcomes including operative time, length of hospital stay, Stone Free Rate (SFR), radiation dose, and postoperative complications were evaluated. The collected data was tabulated and frequency (n) and percentage (%) analysis was performed. The Chi-square test was used to find the level of significance.

Results: A total of 70 patients were included in the study and out of which 35 patients were in the supine (46.37±14.73 years, 28 males and 7 females) and 35 patients (47.54±12.45 years, 23 males and 12 females) were in the prone PCNL groups. Statistically significant difference was observed in the mean operating time in the supine and prone PCNL groups (81.43 vs 127.71 minutes; p-value=0.001), with a higher stone-free rate (94.29% vs 91.43%; p-value=0.643) observed in the supine PCNL group. One patient in supine group had postoperative sepsis and one patient in prone group had bleeding requiring transfusion. The Visual Analog Scale (VAS) score in supine PCNL was (5.08±0.32) less than in prone group (8.03±0.40) (p-value <0.001).

Conclusion: PCNL in the supine position compared with the prone position demonstrates significantly lower operative time with similar SFR and lower VAS score.

Keywords: Percutaneous nephrolithotomy, Prone position, Renal calculi, Supine position

INTRODUCTION

Renal calculus was successfully removed by the use of PCNL in 1976 [1] and it is currently the gold standard procedure for removal of large or complex renal calculi [2]. PCNL in the prone position is accepted for its familiarity, excellent understanding of the anatomy in this position and wider operating field for the surgeon. However, morbidly obese patients and patients with compromised cardiopulmonary status are not suitable for the removal of calculus in this position [3]. In prone position, the hands of the urologists are in the field of the fluoroscopy, which may increase the risk of radiation hazard to the surgeons [4]. PCNL in supine position was described by Valdivia JG et al., who suggested that the colon floats away in the supine position; thereby reducing the chances of injury by a puncture made in the posterior axillary line [1].

Additionally, PCNL in the supine position decreases cardiovascular and respiratory disturbances and includes straight forward renal puncture, spontaneous evacuation of stone fragments facilitated by horizontal sheath position with the hands of surgeon outside the field of radiation. Supine PCNL has uncomplicated patient positioning, less manipulation of the patient under anaesthesia and decreased operating time [5]. The major disadvantage of the supine position is that the kidney is more easily pushed forward by the puncture needle and the dilators, leading to entry through a deeper channel and Bull's eye technique which is routinely used in prone position is difficult in supine position [6]. Ultrasonography (USG) guided punctures are ideal for supine PCNL. Hence, there is a need to compare both the modalities of treatment with an aim to evaluate and compare surgical outcomes in patients undergoing PCNL in supine and prone position.

MATERIALS AND METHODS

A cohort study was conducted on patients admitted to the Urology Department of JSS Hospital, Mysuru between August 2019 to August 2020. As Ethical committee meeting was not held during the Coronavirus Disease-2019, hence Institutional Ethical Committee (IEC) approval was not obtained. However author has taken the permission from Head of Department before conducting the study. Informed consent was obtained from all the participants.

Inclusion criteria: Patients with renal and upper ureteral stones who needed PCNL for stone clearance were included in the study.

Exclusion criteria: Patients with impaired coagulopathy, ectopic and horse shoe kidneys were excluded from the study.

Sample size calculation: The sample size was estimated by using the difference in mean operative time between supine PCNL and prone PCNL from the study by Elgawad AE et al., as 6424 minutes and 8930 minutes, respectively [6]. Using these values at 95% confidence limit and 95% power sample size of 32 was obtained in each group. With 10% non response sample size of 32+3.2≈35 cases were included in each group. A total of 70 patients were included in the study equally divided between two groups.

Alternative patients were chosen for supine and prone PCNL (Odd numbers for supine and even numbers for prone). Informed written consent was obtained from all the patients. Patients were investigated preoperatively with routine laboratory tests, Kidney, Ureter, and Bladder (KUB) Ultrasound, Intravenous Pyelogram (IVP) and spiral Computed Tomography (CT). Preoperative parameters such as age, sex and co-morbidities were recorded. Stone characteristics such as stone size, number of stones, location, Hounsfield units (HU) (900 HU) and any anatomical abnormality were recorded. Patients were admitted one day before surgery and preanaesthetic evaluation was done.

Surgery was performed by same set of surgeons. Supine PCNL was performed under high spinal anaesthesia. The patient was placed in the lithotomy position with the side harboring the stone close to the edge of the operating table. Ipsilateral arm was laid on the thorax and slightly turned to the opposite side. A sand bag was placed beneath the ipsilateral shoulder and gluteal region so as to elevate the ipsilateral flank. A line was drawn connecting the posterior axillary fold and posterior superior iliac spine. Eleventh and twelfth ribs and iliac crest were marked. A puncture was normally done in the area between ribs above, iliac crest below and posterior axillary line anteriorly. Standard antiseptic preparation and draping was done [Table/Fig-1]. A broad spectrum antibiotic was administered intraoperatively.

[Table/Fig-1]: Position of the patient undergoing PCNL in the supine position.
PCNL: Percutaneous nephrolithotomy

Standard cysto-urethroscopy was done and a 6 French (Fr) open-tip uretheral catheter was inserted into the ipsilateral ureter and Percutaneous (PCS) under fluoroscopy guidance. Retrograde pyelogram was performed and ideal calyx for puncture was determined based on the anatomy and stone characteristics.

A kidney puncture was done under C arm guidance after delineating the pelvicalyceal system with 76% urograffin dye from the ureteric catheter. An 18-gauge puncture needle was advanced through the cup of the desired calyx. Multiple punctures were done when required and second puncture was done before initiating the dilatation in case of complex and multiple stones. A 0.032 inch floppy-tip terumo guidewire was advanced into the chosen calyx and coiled in the PCS. Tract dilatation was done with serial dilators under fluoroscopic guidance. A 15-26F dilatation was done depending on the stone burden and then a standard 20 Fr, rigid nephroscope was used for stone fragmentation and stone retrieval in standard PCNL and 12F nephroscope was used for mini PCNL. Pneumatic Lithoclast was used for stone fragmentation. A second tract was made when needed. A 6F 26 cm Double J (DJ) stent was placed in all the patients. Nephrostomy tube was kept at the end of the procedure in selected cases indications being bleeding, PCS injury and residual calculi needing re-look procedure. Operative time, radiation dose, stone clearance and any intraoperative complications were recorded.

Patient was kept in the observation area for four hours and shifted to ward if stable. Patient was started on oral liquids same evening and soft diet was given next day morning. Tab. Paracetamol was administered as an analgesic. Antibiotics were given for 48 hours. X-ray KUB was done routinely on first postoperative day and any residual calculi were recorded. Visual Analog Scale (VAS) score [4] and any postoperative complications were recorded. Percutaneous Nephrostomy (PCN) tube if kept was removed on first postoperative day and catheter was removed on second day. Patient was discharged on second postoperative day. Patient was called for follow-up after one week and DJ stent removed 3-4 weeks after surgery. X-ray KUB was done in all the patients before stent removal and any residual calculi >4 mm was considered as significant residual fragment. Non contrast CT was done in selected cases.

Prone PCNL was done by the same set of surgeons and same preoperative and peroperative protocol was followed. Majority of the cases were done in spinal anaesthesia (20 cases) and rest were administered general anaesthesia (15 cases). After inserting the ureteric catheter, patient was turned into prone position carefully protecting the spine and airway. Operating side was placed near the edge of the table. Puncture was done using triangulation or Bull's eye technique. Rest of the procedure was similar to supine PCNL and all the intraoperative and postoperative parameters were recorded.

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) 2.0 version. Categorical data was reported in the form of frequency and proportion. Chi-square test was used as test of significance for categorical data. Continuous data was reported as mean±Standard Deviation (SD). Independent t-test was used as test of significance to identify the mean difference between two quantitative variables. The $p<0.05$ was considered as statistically significant

RESULTS

A total of 70 patients were included in the study; 35 patients in the supine PCNL group and 35 patients in the prone PCNL group. Overall, baseline characteristics were similar between the two groups; A statistically significant difference was observed between the mean BMI in the supine and prone PCNL groups (24.66 vs 27.09; p-value=0.014) [Table/Fig-2].

Parameters	Supine PCNL (n=35)	Prone PCNL (n=35)	p-value
Age; mean±SD (years)	46.37±14.73	47.54±12.45	0.721$
Sex; n (%)			
Male	28 (80)	23 (65.7)	0.178€
Female	7 (20)	12 (34.3)	
BMI; mean±SD (kg/m^2)	24.66±4.31	27.09±3.76	0.014$
Co-morbidities, n (%)			
Diabetes mellites	13 (37.14)	13 (37.14)	1.00€
Hypertension	15 (42.86)	15 (42.86)	1.00€
COPD	3 (8.57)	2 (5.71)	0.642€
IHD	4 (11.43)	5 (14.29)	0.721€

[Table/Fig-2]: Baseline characteristics.
BMI: Body mass index; COPD: Chronic obstructive pulmonary disease; IHD: Ischaemic heart disease; $Independent t-test was used and €Chi-square test was used

The mean stone size in all subjects was 23 mm+0.25 mm. The predominant stone location in both the groups was pelvic calculus which was 51.4% and 37.1% in supine and prone groups, respectively. Four patients in supine and six patients in prone group had upper ureteric stones which were removed by either push back PCNL or by in-situ fragmentation in case of impacted stones [Table/Fig-3].

Stone location	Supine PCNL n (%)	Prone PCNL n (%)
Upper pole calculus	0	1 (2.86)
Mid pole calculus	0	1 (2.86)
Pelvic calculus	18 (51.43)	13(37.14)
Lower pole calculus	2 (5.71)	3 (8.57)
Partial staghorn	10 (28.57)	8 (22.86)
Complete staghorn	1 (2.86)	3 (8.57)
Upper ureteric stones	4 (14.29)	6 (17.14)
Stones at multiple locations	4 (11.4)	6 (17.14)

[Table/Fig-3]: Stone location.
PCNL: Percutaneous nephrolithotomy; n=35 in each group

Predominant puncture site was mid pole (62.85%) in supine group and upper pole (45.71%) in prone group. Multiple punctures (maximum of two punctures) were performed in about 17.4% patients in supine group and 22% patients in prone group [Table/Fig-4].

Puncture site	Supine PCNL number (%)	Prone PCNL number (%)
Upper pole	5 (14.2)	16 (45.7)
Mid pole	22 (62.9)	13 (37.1)
Lower pole	14 (40)	14 (40)
Multiple punctures	6 (17.4)	8 (22)

[Table/Fig-4]: Puncture site.
PCNL: Percutaneous nephrolithotomy

Operating time was calculated as time between induction of anesthesia till the end of surgical procedure signified by PCN insertion or skin suturing. The mean operating time in supine PCNL was 81.43 minutes and 127.71 minutes in prone PCNL. Authors found significant difference in the operating time between both the groups (p-value=0.001).

Radiation dose was calculated from the insertion of ureteric catheter to DJ stent insertion at the end of the procedure. The radiation dose was 100.45±18.96 mSV in supine group compared to 112.65±16.09 mSV in prone group. These values were not statistically significant. PCN placement post procedure was decided based on predefined indications. A total of 7 (20%) patients in supine and 6 (17.1%) patients in prone group had PCN placed after the procedure. SFR was defined as <4 mm residual calculi or complete stone clearance at the time of stent removal. SFR in the supine group was 94.29% compared to 91.43% in prone group. SFR was comparable in both groups and was statistically not significant. Length of hospital stay was defined as from the time of admission to hospital till medically deemed fit for discharge. The length of hospital stay was similar between both the groups (2.7 days vs 2.8 days) and statistically not significant [Table/Fig-5].

Variable	Supine PCNL (n=35)	Prone PCNL (n=35)	p-value
Operating time; mean±SD (min)	81.43±25.83	127.71±15.30	0.001
Radiation dose; mean±SD (mSv)	100.45±18.96	112.65±16.09	0.05$
PCN placement	7 (20%)	6 (17.14%)	0.09€
SFR (%)	33 (94.29)	32 (91.43)	0.643€
Length of stay; mean±SD (days)	2.74+0.886	2.8+0.531	0.744$

[Table/Fig-5]: Surgical outcomes.
PCN: Percutaneous nephrostomy; SFR: Stone free rate; $: Independent t-test and €: chi-square test

In the supine PCNL group, one patient had postoperative sepsis as evidenced by fever with chills, flank pain and raised total counts. Symptoms started on postoperative day one. Symptomatic management and antibiotics based on urine culture were continued. Patient's symptoms started resolving by day three and wash haemodynamically stable and symptom free at the time of discharge on day five.

In the prone group, one patient required blood transfusion as there was significant drop in haemoglobin from 10.2 gm/dL (preoperatively) to 6.9 gm/dL (within four hours of procedure). Patient was transfused two units of packed Red Blood Cell (pRBC) with continued supportive treatment. Bleeding stopped with conservative treatment and urine was clear 24 hours after the procedure. Postoperative USG did not show any significant perinephric collection. Patient was haemodynamically stable and discharged on postoperative day five with haemoglobin of 9.0 gm/dL and clear urine [Table/Fig-6].

Complications, n (%)	Supine PCNL (n=35)	Prone PCNL (n=35)	p-value
Total complications	1 (2.86)	1 (2.86)	0.770
Sepsis	1 (2.86)	0	-
Bleeding requiring blood transfusion	0	1 (2.86)	-
Urine leak	0	0	-

[Table/Fig-6]: Postoperative complications.
Chi-square test

VAS score was calculated for first 24 hours after the procedure. It was calculated in all patients of prone and supine group with or without PCN placement. Pain score was less in patients in the supine group compared to prone group in patients who had PCN tube in-situ and it was statistically significant. There was no significant difference in pain score in patients who did not have PCN tube placement [Table/Fig-7].

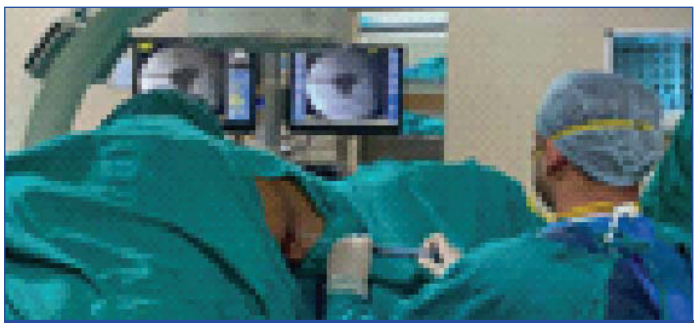
Variable	Supine	Prone	p-value
VAS with PCN	5.08±0.32	8.03±0.40	**<0.001**
VAS without PCN	3.5±1.4	4±1.5	0.151

[Table/Fig-7]: VAS pain score.
VAS: Visual analog scale; PCN: Percutaneous nephrostomy; Independent t-test is used for statistics

DISCUSSION

The PCNL in prone position has been the standard of care for many years for large renal and upper ureteric stones. It is commonly done under general anaesthesia as it is better to secure the airway before turning the patient to prone position [7]. Turning the patient to prone position is labour intensive and requires more number of Operating Room (OR) assistants especially in obese patients and can be cumbersome at times. Prone position in obese and cardiac patients may result in cardiopulmonary disturbances because of decreased venous return and reduced respiratory [7]. Simultaneous access to the ureter is not possible when the patient is in prone position although some modifications have been suggested which help in limited access to the ureter [8].

Majority of the supine PCNL are done under spinal anaesthesia as the airway is easily accessible in this position [9,10]. Once the patient is in proper position there is no need for change of position for rest of the procedure. Another advantage is simultaneous access to the ureter (Bilateral ureters) which is needed sometimes for migrated stones during PCNL or for difficult stent placements. Planned Endoscopic Combined Intra Renal Surgery (ECIRS) may also be performed [11-13]. This procedure requires less number of OR assistants compared to prone PCNL. Additionally, risk of musculoskeletal and ocular complications is reduced in patients undergoing supine PCNL. Supine PCNL is conducted with the surgeon in sitting position which increases the surgeon comfort as this procedure is done wearing heavy lead shield coats for a prolonged period of time [7]. Another advantage is reduced radiation exposure in supine PCNL compared to prone PCNL as the surgeon's hands are placed laterally outside the exposure area [Table/Fig-8].



[Table/Fig-8]: Demonstrating the surgeon position and comfort in supine PCNL.

In the present study, the total number of patients was 70 which is similar to studies described by Sherif H et al., [4]. In the study conducted by Elgawad A et al., and Jones MN et al., where the supine position was found to have a mean reduction of 30 and 25 minutes, respectively when compared with the prone position [6,8]. In the study conducted by Wang Y et al., the mean operating time was significantly lower (78 min vs 88 min, p-value <0.05) in the prone position group than in the modified supine position group [3].

In the present study, authors found a shorter operative time in the supine PCNL group (81.43 min) compared with the prone PCNL group (127.71 min). This difference could be accounted for not repositioning the patient to prone position after ureteric catheter insertion and consequently repeat preparation and draping. Also, staff rescrubbing and gowning is not needed in supine position. Supine position also helps in faster retrieval of stone fragments as the sheath position is horizontal compared to prone position, which is very useful in Mini-perc and in patients with staghorn calculus. All these factors together help in reducing the operating time in supine PCNL.

In the study conducted by Wang Y et al., the SFR was significantly higher (88.7% vs 73.3%, p-value <0.05) in the prone position group than in the modified supine position group [3]. In the study conducted by Melo PAS et al., which compared the outcomes of PCNL in prone position and in three variations of the supine positions, SFR was similar between both the groups [2].

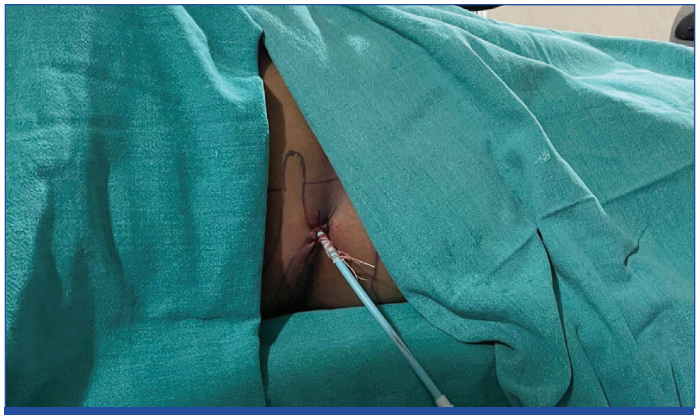
Similarly, in the study by Jones MN et al., the SFRs were not significant between PCNL in the prone versus modified supine position [8]. In the study, conducted by Valdivia JG et al., the stone-free rate post-PCNL was significantly higher among prone-positioned patients [1]. The present study did not show a statistically significant difference in the SFRs between the two groups. The higher SFR in prone position in some of the studies may be due to familiarity with the prone PCNL and initial learning curve associated with supine PCNL. As the surgeon becomes familiar with supine PCNL similar stone free may be achieved with added advantages and comfort of supine PCNL. [Table/Fig-9] shows studies comparing mean operating time and SFR in both the groups.

Various studies	Time (Min)		Stone Free Rate (SFR)	
	Supine	Prone	Supine	Prone
Jones MN et al., [8]	93±45.5	123±49.5	70%	50%
Abd Elgawad AE et al., [6]	64±24	89±30	86.7%	73.7%
Sherif H et al., [4]	70	-	93.6%	-
Wang Y et al., [3]	88	78	44%	55%
Valdivia JG et al., [1]	100	89	63.3%	76.9%
Present study	81.43±25.83	127.71±15.30	94.29%	91.43%

[Table/Fig-9]: Comparison of mean operating time and Stone Free Rates (SFR) in the supine and prone PCNL position across various studies.

In the study conducted by Valdivia JG et al., over all peri-operative morbidity occurred rather in frequently, regardless of the positioning of the patients ranging in frequency from 1.4% to 11.1% [1]. Nevertheless, the rate of failed procedures in which access to the kidney was not accomplished was slightly higher among supine-positioned patients (2.7% vs 1.5%; p-value=0.01). Conversely, patients in the prone position exhibited higher rates of blood transfusions (6.1% vs 4.3%; p-value=0.026) as well as fever (11.1% vs 7.6%; p-value=0.001). In the present study, postoperative complication occurred in one patient in the supine PCNL group (sepsis) and in one patient in the prone PCNL group (bleeding requiring blood transfusion). Both the complications were classified under Grade 2 Calvein Dindo classification and were conservatively managed [4].

Authors found significant less postoperative pain in supine compared to prone groups in patients in whom PCN was placed and it was statistically significant. This could be explained because of lateral position of PCN in supine group compared to prone where patient lies over the PCN tube causing more pain postoperatively and requiring more analgesics. This is a significant factor which not only decreases the analgesic requirement but also increases patient comfort and satisfaction [Table/Fig-10].



[Table/Fig-10]: Demonstrating lateral position of PCN tube with significant distance from the edge of the table.
PCN: Percutaneous nephrostomy

There was no statistically significant difference in the average stay in the hospital between the two groups. This is similar to other studies which also did not find any difference in duration of hospital stay between two groups [2,5]. This is because of the similar SFR and complication rate in both the groups resulting in lesser need for re-look PCNL and prolonged hospitalisation. PCNL in the supine position compared with the prone position demonstrated significantly lower operative time with similar SFR and lower pain score.

Limitation(s)

The present study had a small sample size and upper pole puncture in supine PCNL group was less.

CONCLUSION(S)

PCNL in supine position confers the advantages of uncomplicated patient positioning, anaesthesia ease, less radiation exposure to surgeon hands, and better postoperative pain score compared to prone PCNL. Hence, supine PCNL may be considered as an alternative to prone PCNL with a comparable stone clearance rate.

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