Original Article

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A Prospective Study of Supine Percutaneous Nephrolithotomy with a Modified Technique: A Safe and Desirable Tool in the Armamentarium of Urologists

Surgery Section

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ABSTRACT

Introduction: Supine Percutaneous Nephrolithotomy (PCNL) has failed to gain popularity despite the various advantages, primarily due to a lack of standardised technique. A simple and replicable technique is needed to increase its popularity amongst urologists.

Aim: To simplify and standardise the puncture technique of supine PCNL and compare it with the Clinical Research Office of the Endourological Society (CROES) PCNL global study.

Materials and Methods: A prospective interventional study was conducted in a tertiary care hospital in Dehradun, Uttarakhand, India, between June-December 2020. A total of 82 consecutive patients underwent the procedure with a modified technique of initial puncture using bony landmarks. The results of present study were compared with the outcomes of the patients who underwent supine PCNL in the CROES PCNL global study which is the largest prospective database regarding the supine and prone positions of PCNL till date. Statistical analysis of various demographic variables, patient characteristics and results was done using Statistical Package for the Social Sciences (SPSS) version 24.0 software.

Results: The mean age of patients was 47.52±13.044 years and mean stone burden of 266.146±172.430 mm^2. The mean operative time was 85.59±12.733 minutes. Lower calyceal puncture was done in 97.56% of patients. Stone clearance was achieved by a single puncture in 73 (89.0%) patients while 9 (11.0%) patients required two punctures. Sixteen patients (19.51%) had postnephrostomy drain removal leak which settled within 24 hours. Only in one patient the leak continued beyond 24 hours but was managed conservatively. On comparison, it was observed that mean stone burden was lesser (p-value=0.0001) and the stone free rate was comparatively higher in present study (p-value=0.024).

Conclusion: Supine PCNL is an effective and safe procedure in a subset of patients with predominant lower calyceal stone bulk.

Keywords: Endoscopic surgery, Renal calculi, Simplified technique

INTRODUCTION

PCNL is the most preferred and widely used procedure for the removal of large and complex renal calculi. In recent years, it has almost completely replaced open surgery. It was first described by Fernstrom I and Johansson B [1]. Since then, it is traditionally done with the patient in prone position, with a high success rate and acceptable morbidity. As prone position is not acceptable for all patients particularly morbidly obese and patients with respiratory compromise [2-6], the demand for easier and more comfortable access to the entire urinary tract for combined retrograde and antegrade endoscopic surgery, led to the introduction of alternative patient positions for PCNL. Some of these were not widely accepted in the urological community but all of them had a significant role in the dynamic process of further refinement [7].

There have been several positional modifications in the technique of PCNL [8-10]. Valdivia JG et al., in 1987-88 reported a safe access to the kidney in a supine patient and their in-vivo experience was reported 10 years later [2,8]. In supine PCNL, as the abdominal wall is punctured more laterally, away from the lumbar muscles, the movements of the endoscopic instruments are less restricted. The direction of the tract maintains a low pressure in the renal pelvis, and thereby reduces the risk of fluid absorption and allows even spontaneous clearance/washout of fragments. There are other multiple benefits also like avoidance of supra costal (pleural) puncture, intercostal vessel and nerve injury and simultaneous access for uretero renoscopy for migrated or residual stones [8-13]. The presumed risk of bowel and other solid organ injury has been comprehensively allayed by numerous anatomical Computed Tomographic (CT) studies [2,11,12].

Despite these advantages, supine PCNL has not gained the confidence of urologists in general. The present study aims to standardise and simplify the puncture technique for supine PCNL to improve its acceptability. The study also aims to compare the outcomes with the supine PCNL arm of the CROES global PCNL study [14].

MATERIALS AND METHODS

A prospective interventional study was conducted at Shri Mahant Indiresh Hospital, a tertiary care centre in Dehradun, Uttarakhand, India, between June-December 2020 after taking approval from the Institute Ethics Committee (IEC) (SGRR/IEC/4419). Convenience sampling method was adopted.

Inclusion criteria: Patients (aged 20-70 years) with renal and/or ureteric stones and giving informed consent.

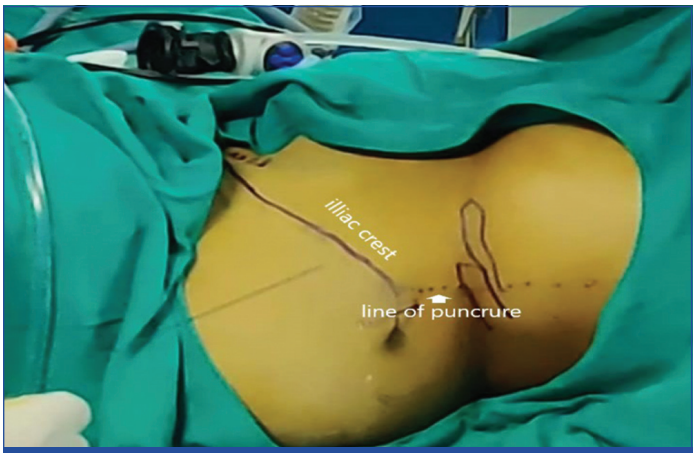
Exclusion criteria: Absolute contraindications for PCNL (namely sepsis, blood coagulation abnormalities), previous history of ipsilateral laparoscopic or open renal/abdominal surgery, multiple calyceal calculi requiring multiple punctures, bifid pelvicalyceal system with upper calyceal stone mass.

Study procedure: A total of 82 consecutive patients with renal stone disease who presented to Department of Urology were included and underwent PCNL in the supine position with modified technique under spinal or general anaesthesia. All the patients had necessary clearance and underwent preoperative evaluation (of routine haematological and biochemical parameters) for surgery and anaesthesia (American Society of Anesthesiologists (ASA) Grade) [15]. Postoperative pain was assessed using Visual Analogue Scale (VAS) and analgesics were administered as per the score [16]. Body Mass Index (BMI) was

calculated and the patients were classified using the World Health Organisation (WHO) classification of obesity [17].

Modified technique of calyceal puncture

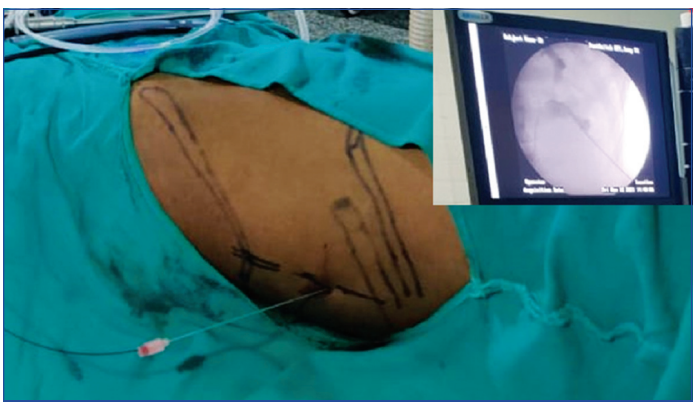
Positioning: After giving anaesthesia, patient was positioned in supine position with a bolster placed under ipsilateral scapula and rib cage (not extending below 10th rib). This bolster could be a silicone bolster or 500 mL intravenous fluid plastic bottle with average thickness of 3 inches. The purpose of putting the bolster under thorax was to bring lower pole of kidney at the level of highest point of iliac crest for calyceal puncture. The thickness and placement of the bolster is very important as a thicker bolster placed further down could lift the lower pole of kidney beyond the level of highest point of iliac crest and could also bring colon in the trajectory of puncture needle [Table/Fig-1].



[Table/Fig-1]: Skin markings for initial puncture.

The window for entry of the puncture needle was between iliac crest and the 12th rib. After prepping the patient, ureteric catheterisation was done in either frog leg position or Galdakao modified position if simultaneous ureteroscopy was planned [7].

Surface marking for initial puncture: A horizontal line drawn from a point just below highest point of iliac crest to the 12th rib, serves as the site of puncture. The use of the posterior axillary line in determining the entry site can be fallacious in obese or very thin patients. Rather, the use of fixed bony landmarks is more uniform and therefore desirable. The preferred calyx for entry was usually the lower calyx and sometimes the middle calyx if it was accessible through the window [Table/Fig-2].



[Table/Fig-2]: Puncture needle in place at the desired site.

The needle entry tract should be in a straight line with the desired calyx and renal pelvis as guided by monoplanar flouroscopy. Care was taken to keep the puncture needle parallel to the operating table while entering the desired calyx. A pyelogram obtained via a pre placed ureteric catheter assisted in puncturing the desired calyx.

After placing guide wire into the pelvicalyceal system and preferably in the ureter, tract dilatation was done using Alken's dilators under fluoroscopic guidance and a 22F or 24F Amplatz sheath used depending on the diameter of calyx.

In most of the cases, the nephroscope could easily reach the upper and the middle calyx albeit with some angulation. If required, simultaneous ureterorenoscopy could be done to retrieve fragments. Complete clearance was possible in most of the cases. A double-J stent and nephrostomy drain was placed in all cases.

STATISTICAL ANALYSIS

The variables compared were demographic variables (age, sex and BMI), ASA grade, co-morbidities, stone characteristics (side, size, location), operative time, puncture site, stone free rate, postoperative complications and duration of hospital stay. Mean comparison was calculated with the help of Independent t-test and proportion testing was done with the help of z test. SPSS version 24.0 software was used for statistical analysis. A p-value <0.05 was taken as statistically significant.

RESULTS

The mean age of presentation was 47.52±13.044 years. Among the patients, men outnumbered women (M:F-48:34). The mean BMI at the time of presentation was 26.77±2.209 kg/m^2. Lower calyceal puncture was done in majority i.e., 80 patients (97.56%). In all the patients, the preferred calyx for puncture was anterior lower calyx as it gave easy access to all calyces including middle and upper (both anterior and posterior) calyces. Semi-rigid or flexible ureteroscopy was done (in five patients) simultaneously to retrieve stone fragments from the upper calyces which were difficult to reach due to angulation. In two patients, the stone fragments migrated into inaccessible middle calyces which were at an acute angle to the pelvis and could not be removed.

Sixteen patients (19.51%) had postnephrostomy drain removal leak which settled within 24 hours. Only in one patient the leak continued beyond 24 hours but was managed conservatively. A single shot of analgesic was given to all patients in postoperative period within 12 hours. A total of 43 (52.43%) patients required analgesic after 24 hours of surgery whereas 19 (23.17%) patients required analgesic after 48 hours. Nine (11.0%) patients required analgesics even after 2 days of surgery. The results were compared with the outcomes of the patients who underwent supine PCNL in the CROES PCNL Global study [14], which included patients from various countries [Table/Fig-3,4]. On comparison, it was observed that the subjects in present study were comparatively younger (p-value=0.0373) and therefore had lesser co-morbidities. The mean stone burden was lesser

Sl. no.	Criteria	Present study (n=82)	CROES PCNL Global Study [14] (n=1138)	p-value
1	Mean age (years)	47.52±13.044	51±14.7	0.0373
2	Male: Female	48:34	52.2%:47.8%	-
3	Mean BMI (kg/m^2)	26.77± 2.209	26.6±4.6	0.7401
4	**ASA score**			
	I	44 (53.66%)	46.80%	0.201
	II	27 (32.93%)	42.00%	0.004
	III	8 (9.76%)	10.30%	0.314
	IV	3 (3.65%)	0.80%	0.012
5	**Co-morbidities**			
	Diabetes	5 (6.09%)	12.80%	-
	Cardiovascular disease (including hypertension)	2 (2.43%)	23.40%	
	Respiratory problem	3 (3.65%)	-	
	Obesity	7 (8.53%)	-	

[Table/Fig-3]: Demographic variables.
*variables 1 and 3 use independent t-test. Rest use z- test

(p-value=0.0001) and the stone free rate was comparatively higher in present study (p-value=0.024).

Sl. no.	Criteria	Present study (n=82) Value (%)	CROES PCNL Global Study [14] (n=1138)	p-value
1	Stone burden (mm^2)	266.146±172.430	470.6±386.4	0.0001
2	**Type of stone**			
	Pelvic	27 (32.93%)	-	-
	Staghorn	22 (26.82%)	25.40%	
	Calyceal	26 (31.71%)	-	
	Upper ureteral	7 (8.54%)	-	
3	**Side of surgery**			
	Right	49 (59.75%)	-	-
	Left	33 (40.25%)	-	
4	Mean operative time (minutes)	85.59±12.733	90.1±43.3	0.3474
5	**Puncture site**			
	Upper	Nil	4%	-
	Mid polar	Nil	17.10%	
	Lower	80 (97.56%)	74.80%	
	Multiple	02 (2.44%)	4.10%	
6	Location of access – above 11^{th} rib/ Above 12^{th} rib/ Below 12^{th} rib	Below 12^{th} rib=82(100%)	Below 12^{th} rib = 93.3%	-
7	Number of puncture Tracts– One/Two/Three />3	1=73 (89.0%)/ 2=9 (11%)	-	-
8	Stone free rate	80 (97.56%)	70.20%	0.024
9	Haemoglobin drop (mg/dL)	0.8±0.13	-	-
10	Blood transfusion required (units)	Nil	4.30%	-
11	Fever	Nil	7.60%	-
12	Port site infection	Nil	-	-
13	Urinary tract infection	Nil	-	-
14	Enteric fistula/visceral injury/ perforation	Nil	3.40%	-
15	Postoperative tract leak 24 hours	1 (1.22%)		-
16	Renal injury	Nil		-
17	Pleural injury/ Hydrothorax	Nil	1.40%	-
18	Postnephrostomy drain removal leak	16 (19.51%)	-	-
19	Pain (according to VAS) (mean)			
	12 hours postoperative	6.5±0.7)	-	-
	24 hours postoperative	4.4±0.4	-	
	48 hours postoperative	2.1±0.3	-	
20	**Analgesic**			
	Not required at all	Nil	-	-
	Required - After 12 hr	Given to all	-	
	- After 24 hr	43 (52.43%)	-	
	- After 48 hr	19 (23.17%)	-	
	- >48 hr	9 (10.97%)	-	
21	Mean duration of hospital stay (days)	4.18±0.93	4.2±3.8	0.7755

[Table/Fig-4]: Results and comparison with CROES global study.
Variables 1, 4, 8 and 21 use independent t-test.

DISCUSSION

The effective position for PCNL has always remained a topic of debate among the urologists around the globe. Various centers have a fixed protocol regarding the same. The CROES PCNL global study is the largest prospective database regarding the supine and prone positions of PCNL till date [14].

In the present study, authors have endeavored to simplify the technique of supine PCNL so that it can be reproduced and mastered with relative ease as the puncture site is in relation to a fixed bony landmark. In order to test the results, authors compared the results with the outcomes of the patients who underwent supine PCNL in the CROES PCNL global study which included patients from various countries. The results were found to be comparable [Table/Fig-4]. The limitation of such a comparison between two heterogeneous groups with varied inclusion criteria is well understood. Despite the various well-documented advantages of supine PCNL, it has failed to gain the confidence of an average urologist. This is partly due to the fear of inadvertent bowel/visceral injury and partly due to the lack of a standardised technique of calyceal puncture. The former has been comprehensively addressed by numerous anatomic studies, which have proven the fears to be false [11,12]. Authors have attempted, in this study, to simplify the technique of calyceal puncture so that it can be reproduced by any urologist. The over reliance on the use of posterior axillary line for initial puncture, in our opinion, can lead to a higher failure rate especially in obese and very thin individuals. Moreover, in a draped patient the posterior axillary line is not readily visible if the need to revisit the puncture site arises intraoperatively. Thus, bony landmarks, namely the 12^{th} rib and iliac crest were used in guiding the initial puncture site, and have succeeded with comparable results.

Another major advantage of the supine position is that simultaneous procedures (antegrade and retrograde) can be done for clearance of migratory stones. Seven of the patients in this study had upper ureteric stones, which were fragmented partially or pushed back into the kidney, and removed percutaneously without changing the position of the patient. This is advantageous in setups, like ours, where flexible ureteroscope and lasers are not readily available. Ergonomically also, supine PCNL favors both, the urologist and the anaesthesiologist.

Access through lower calyx usually gives easy access to superior and middle calyx unless it is at an acute angle so stone clearance is done with minimal need of additional puncture. As suggested by Sofer M et al., access to superior calyx is easier in supine position in comparison to prone position [18]. In a randomised study of 38 patients with upper calyceal stones Soliman T et al., concluded a better stone clearance rate with supine as compared to prone PCNL [19]. Another recently published study also claimed better stone clearance and lesser complications with supine PCNL for lower calyceal stones [20]. Therefore, the benefits of this procedure can only be made available to the patients only when the procedure becomes standardised, simplified and reproducible. Authors have endeavored to achieve this by present study.

Limitation(s)

The inferior calyx was punctured in all patients and only two patients required additional middle calyceal puncture. In none of the patients upper calyx was accessed percutaneously, which may be a drawback of this technique. This problem can be partially overcomed by the judicious use of flexible nephroscopes. Although reported by others, supracostal and upper calyceal punctures were not done in the current study. These can be the subject of further studies. One problem which was encountered in two patients where the stone fragments migrated into inaccessible middle calyces which were at an acute angle to the pelvis, thereby precluding access. Inaccessibility by nephroscope can also result when stone fragments migrate into other anterior calyces

CONCLUSION(S)

Supine PCNL is an effective and safe procedure in a subset of patients with predominant lower calyceal stone bulk. It has the potential to become the procedure of choice in this subset. In patients with upper ureteric calculi, supine PCNL provides concomitant antegrade and retrograde access, without the need for changing patient position.

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