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Comparative Study of Percutaneous Nephrolithotomy in Supine and Prone Positions

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ABSTRACT

Background: The aim of the study is the compare efficacy and safety of percutaneous nephrolithotomy in supine and prone positions. Percutaneous nephrolithotomy is conventionally performed in prone position but in recent years numbers of supine percutaneous nephrolithotomies is increasing globally.

Methods: The hospital based cross-sectional observational study was conducted in the Department of Urology, Bir Hospital from July 2018 to January 2020. A total of 81 consecutive patients undergoing percutaneous nephrolithotomy were divided into two groups, with 38 patients in Supine (Group 1) and 43 patients in Prone (Group 2) positions, respectively. Patient's demographics, access time, operative duration, stone free rate, radiation dose and duration, irrigation fluid volume, post-operative hemoglobin drop and complications were compared.

Results: Demographic and stone characteristics were comparable in both groups. Supine Group (Group 1) had significantly shorter operative duration than Prone Group (Group 2), 44.63 ± 12.44minsvs 53.02 ±12.67mins ($p< 0.04$). The mean radiation duration was 99.11 ± 61.17secs in Group 1 and 108.40 ± 51.65 secs in Group 2 ($p=0.46$), respectively. Although the mean radiation dose was lower in Group 1 (375.1µGym^2) than in Group 2 (465.7 µGym^2), it was not statistically significant($p=0.24$). The stone free rate at 1 month duration were comparable with 92.1% and 93.02% in Group 1 and Group 2 respectively ($p=0.16$). Overall complication rates were similar in both groups (15.7% in Group 1 vs 16.2% in Group 2), respectively. None of the patients in both groups had complications higher than Clavien IIIa.

Conclusions: PCNL in supine position has significantly shorter operative time with similar complications and stone free rates as compared to prone position.

Keywords: percutaneous nephrolithotomy; prone position; supine position

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is commonly done in prone position due to familiarity with the procedure, larger surface area and potentially more direct approach to the kidney.[1] However, prone position has its disadvantages regarding anesthetic, logistic and surgical aspects.

Supine position is more safer and feasible over the prone position in terms of reducing operation time, avoiding injuries during repositioning, reducing radiation exposure to the surgeon, ability to perform in sitting position and a simultaneous PCNL and ureteroscopy.[2] Mobility of the kidney and limited working space may cause difficulty during supine position.[3] However, equivalent stone free and complication rate have been reported in prone and supine position PCNL in various studies.[4]

Though, large number of PCNLs are performed in our country, there have been no published systematic studies comparing the supine with the prone position. Therefore, we compared the efficacy and safety of PCNL in the traditional prone and supine positions.

METHODS

The prospective observational study was conducted over the period of 18 months from July 2018 to January 2020 in the Department of Urology, Bir Hospital after approval from Institutional Review Board of National Academy of Medical Sciences. Informed consent was taken from all patients. Inclusion criteria were patients with renal stones diagnosed with NCCT KUB. Exclusion criteria were age below 14 years, active urinary tract infection, simultaneous bilateral procedures, second stage PCNL patients with PCN tube in situ and patients not reporting

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with X-ray KUB and USG after 1 month. Stone burden is both the groups were calculated using NCCT KUB and measured as (Length x Width x Height) stone volume mm^3 rather than single longest diameter as stone size.

PCNL was performed by consultant urologist according to the standard technique. Prophylactic antibiotic (Inj Ceftriaxone 1 gm) was given intravenously 30 mins before the anesthesia. Both supine and prone procedures were performed in spinal anesthesia. After spinal anaesthesia patient was placed in lithotomy position and cystoscopy was done to place 6 Fr (Indovasive) straight tip both end open ureteral catheter in ipsilateral pelvicalyceal system under fluoroscopic guidance in both the groups. For supine (Group 1) patients, a special bolster was prepared in wedge shape which was 50 cm long, 15 cm wide with a 20 degree angle of inclination. The bolster was kept under the hips and shoulders of ipsilateral side to elevate the flank from the operation table. After positioning and inserting the ureteral catheter, all cases followed the same procedure. A retrograde pyelogram was performed. Under fluoroscopic guidance, the desired calyx was punctured using two-part needle and a Terumo 0.035"guidewire was inserted. The number of punctures and pole of punctures were determined by the size and location of the calculus. Guide wire was positioned in upper ureter. Single step dilatation was done with a metallic fascial dilator and Amplatz sheath (16-24F) were placed. Nephroscopy was done with 12 (Karl Stroz) or 21 French (Richard Wolf) Rigid Nephroscope. Stones were identified and fragmented with pneumatic lithotripter or Shockpulse (Olympus). Small stones and fragments was removed with forceps or flushed out with irrigation pump. The exit strategies were total tubeless, tubeless or standard depending on the duration of surgery and surgeon's preference. Duration of radiation exposure and radiation dose in both the groups were noted. For Prone (Group 2) patients, after insertion of ureteric catheter in lithotomy position, all procedures were completed in prone position.

Operation time was defined as the time from ureteral catheterization to the exit. On first postoperative day, Foley's catheter was removed and if any nephrostomy tube was placed it was removed on second postoperative day. If the patient was comfortable, afebrile, and with a dry nephrostomy site, the patient was discharged on the same day of nephrostomy removal. JJ stents were removed after 2 weeks.

A stone-free state was defined as no residual stones on X-ray KUB and USG of KUB done by consultant radiologist at one month follow up. Non-obstructive residual stones ≤ 4 mm on USG and Xray KUB were defined as clinically insignificant. Patients with residual fragments were treated with RIRS or second phase PCNL. Postoperative complications were classified according to the modified Clavien grading system.[5]

Patient demographics were collected. Measured data included radiation dose, radiation duration, stone free rate, stone volume, operative time, access time, irrigation volume, pre and postoperative hemoglobin drop and postoperative complications.

SPSS software package (versions 16.0, SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses. The results were expressed as the mean ± standard deviation and range. Fisher's exact test and students *T* test were applied to find out the significant differences between the two groups. p value < 0.05 was considered statistically significant.

RESULTS

During the study period, a total of 90 PCNLs were performed among them 38 patients in supine group and 43 patients in prone group fulfilled the inclusion criteria and 9 patients had to be excluded due to various reasons. The groups were homogenous. There were no significant differences in numbers of patients, sex distribution, age, body mass index (BMI), stone volume and laterality (P >0.05) between groups (Table 1).

Table 1. Clinical characteristics of Patients.

	Supine (Group 1)	Prone (Group 2)	P Value
No. of patients	38	43	
Age (years), mean ± SD	40.08±12.93	41.44±13.95	0.65
BMI kg/m^2, mean± SD	22.64±2.65	24.08±4.59	0.094
Stone volume (mm^3), mean± SD	1383.53± 1135.76	1338.09± 1093.69	0.85
Laterality: Right/Left Hounsfield unit (HU), mean± SD	14/24 1024.7± 371.27	19/24 1090.6± 286.40	0.37

The mean (SD) operation time was 44.63±12.44 min for Supine (Group 1) and 53.02±12.67 min for Prone(Group 2), which was statistically significant. The overall stone free rate was 92.10% in Group 1 and 93.02% in Group 2 respectively. There were no significant differences in mean access time, mean radiation dose and duration, mean irrigation fluid and mean drop in hemoglobin between the groups (Table 2).

Table 2. Comparison of peri-operative results in supine and prone positions.

	Supine (Group 1)	Prone (Group 2)	p Value
No. of patients	38	43	
Access time to puncture (sec), mean ±SD	102.97±36.30	107.95±45.72	0.59
Operative time (min), mean ±SD	44.63±12.44	53.02±12.67	0.04
Radiation time (sec), mean ±SD	99.11±61.17	108.40±51.65	0.46
Radiation dose(μGym^2), mean ±SD	375.17±302.82	465.74±385.82	0.24
Drop in hemoglobin level (g/dl), mean ±SD	1.02±0.54	1.27±0.94	0.16
Stone free rate, %	92.10	93.02	

In Supine (Group 1), six patients (15.7%) developed complications: three (7.8%) had a fever >38C, managed conservatively without antibiotics. Two patients (5.2%) had a fever of >38 C, which needed intravenous antibiotics and one patient (2.6%) was re-admitted with haematuria 2 weeks after surgery and was managed conservatively with antibiotics. Whilst in Prone(Group 2), 7 patients (16.2%) developed complications: 1(2.3%) had a persistent urine leak more than 24 hours and managed conservatively. Two patients (4.6%) had a fever >38 C, managed conservatively without antibiotics and Two patients (4.6%) had a fever >38C, managed with antibiotics. Two patients (4.6%) had a haematuria requiring bladder washing. No patients had ClavienIIIb and higher complications in both the groups (Table 3).

Table 3. Comparison of complications based on modified Clavien classification in supine and prone positions.

	Supine (Group 1)	Prone (Group 2)
Clavien – Dindo I	Fever (3)	Fever (2) Urine leak from Nephrostomy site (1)
Clavien – Dindo II	Fever (2) Haematuria (1)	Fever (2)
Clavien – Dindo IIIa	-	Haematuria (2)
Total (%)	15.7%	16.2%

DISCUSSION

Majority of surgeons prefer PCNL as the procedure of choice for large renal stones, including staghorn. The ideal positioning in PCNL remains a matter of controversy. Till date prone position has been the traditional and most widely used position since PCNL emerged. The CROES PCNL Global Study published in 2011, found that 80.3% of patients were operated in the prone position compared with 19.7% in the supine position.[6] This may be due to the fact that many surgeons learned PCNL from mentors who practice the prone position.[7,8] Supine PCNL is commonly done in some South American centers.[6] Positioning in our center was based on surgeon's preference.

PCNL in the prone position required a longer time, since patients were required to be rolled to prone position after ureteral catheterization and to roll back to the supine position after surgery.[6] A prospective randomized trial by De Sio M et al. had reported that operative time was significantly shorter in supine than in the prone group.[1] The mean operation time in Group 1 was 44.63 ± 12.44 min and 53.02 ±12.67 min in Group 2 (P=0.04). We found that the Supine (Group 1) had shorter operative time. It is important here to mention that, we calculated the operation time from insertion of the ureteric catheter including the time taken in positioning, until the end of the procedure. Our findings are consistent with those of a recent meta-analysis of PCNL positioning by Liu et al. and a prospective randomized trial by Yanbo Wang et al, where the supine position was found to have a mean reduction of 25 and 10 minutes respectively.[9,10]

In our present study, we measured stone volume not the largest stone diameter. Most of the studies report largest single diameter of stone as the size which may not reflect true stone burden. In our study, the mean stone volume in supine and prone groups were 1383.53 ± 1135.76 mm^3 and 1338.09 ± 1093.69 mm^3 (P = 0.85) respectively. Few prospective randomized trials have compared stone free rate in supine versus prone PCNL showing no significant differences between the groups which was similar to our study (93.02% vs 92.10%).[1,11] However, a comparison of positioning by Valdivia et al., which comprised the 5,803 patients from the Clinical Research Office of the Endourological Society's (CROES) prospective PCNL database found that stone-free rates were significantly higher (77% vs 70.2%) for the prone group as compared with supine which was also similar to Wang et al (88.7% vs 73.3%, p< 0.05).[6,10] Our study showed shorter access time, shorter radiation duration, lower radiation dose and low irrigation volume in Supine group than that of Prone group. Several other studies have shown similar results with supine PCNL.[12] In our

study, surgeons who were doing PCNL in both supine and prone position were more comfortable in supine group in sitting position.

Advocates of supine PCNL have suggested that post-operative fever and sepsis is reduced by the theoretical decrease in pyelovenous back flow resulting from the improved drainage of irrigation fluid around the nephroscope in the supine position.[13] However, in our study post-operative complications including fever and septic complications were similar in both the groups. In fact, in all other comparative studies conducted earlier, complication rates were comparable between supine and prone PCNL.[1,11,14]

Limitations of our study include the small sample size, non-randomization of groups and multiple surgeons performing the procedure. However, prospectively collected data, groups with similar demographics and stone aspects, regular use of pre-operative CT, and surgeons with extensive experience make our study relevant.

CONCLUSIONS

PCNL in supine position is a safe and effective procedure, with similar stone clearance and complication rates as that of prone PCNL, while having significantly lesser operative time.

CONFLICT OF INTEREST: None

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