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Original Research Article

Spinal anesthesia versus general anesthesia for percutaneous nephrolithotomy surgeries - a prospective study

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is a minimally invasive surgery for extracting renal and urinary stones, and a choice modality in large, multiple, and stag-horn stones. Anaesthesia for PCNL can be general or regional. Despite good results of PNCL with general anaesthesia, it may cause atelectasis, drug reactions, nausea, and vomiting. General anaesthesia (GA) has its limitations in the form of poor postoperative pain control, greater incidence of nausea and vomiting, prolonged recovery stays and prolonged hospitalizations.
Methods: The study was performed in a tertiary care centre. A prospective, randomised study including 60 patients divided into 2 groups. Data collection tools included study proforma, numerical rating scale (NRS) scores and visual analog scale (VAS) scores. Data analysed using science and statistical packaged (SPSS) version 21, independent t tests and z-test for proportion.
Results: The demographic data when statistically analysed showed no statistically significant differences between the groups. Haemoglobin percentage (Hb%) was significantly lower in GA group. Spinal anaesthesia (SA) group showed lower VAS and NRS scores hence lower requirement of pain relief and antiemetics. The post-operative complications were insignificant.
Conclusions: We concluded that SA is safe and effective method as an alternative method for PCNL surgeries.

Keywords: Percutaneous nephrolithotomy, Spinal anaesthesia, General anaesthesia

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is a minimally invasive surgery for extracting renal and urinary stones, and a choice modality in large, multiple, and stag-horn stones. Furthermore, PCNL can be used in patients with failed shock and endoscopic trials.[1-3] The choice of anaesthetic technique depends on patient and surgeon preference, feasibility of the technique in a given patient, intra and postoperative pain control, skills of anesthesiologist and perioperative costs.

Anesthesia for PCNL can be general or regional. Despite good results of PNCL with general anaesthesia (GA), it may cause atelectasis, drug reactions, nausea, and vomiting.[4,5] It has its limitations in the form of poor postoperative pain control, greater incidence of nausea and vomiting, prolonged recovery stays and prolonged hospitalizations.

In abdominal and lower extremities surgeries, spinal anaesthesia (SA) is mainly employed by a single drug and comprises some advantages such as less bleeding, and reduces venous pressure in the surgery field.[6,7] In most cases PCNL is performed under GA, whereas complications and costs of GA are higher than SA.[8] Complications occur especially when patient's position is changed from supine to prone. The most common

complications are lung, brachial plexus, and tongue and occasionally the spinal cord injury when the position of patient is changed as well as neurological complications and side effects related to displacement of tracheal tube.[9,10]

Some scientific evidence shows that in certain cases, such as patients who are at high risk for surgery, we can use either spinal, epidural, or intrapleural anesthesia.

Due to high rates of complications and costs in GA, we aimed to compare the efficacy and complications of GA and SA in patients who were candidates for PCNL surgeries.[11,12]

Objectives

Objectives of the study include: to assess postoperative pain management by SA in comparison with GA, to compare the requirement of analgesia during the postoperative period, to compare the incidence of postoperative nausea and vomiting, to compare the requirement of antiemetic's during postoperative period, to compare the amount of intra operative blood loss, and to study the incidence of post-operative complications of SA.

METHODS

Source of data

The study was conducted at Lisie hospital (a tertiary care centre), Cochin, India during the period between June 2013 to June 2014. Hospital ethical committee approval was obtained. Patients scheduled to undergo PCNL surgeries under spinal and general anesthesia were enrolled in this study.

Method of collection of data

Sample size

60 patients undergoing percutaneous nephrolithotomy.

Statistical method

For the determination of the sample size for this study we used a previous study, p=53%, q=47%, z=95% confidence coefficient i.e. 1.96, d=13%. The formula given below was used.

$$n \geq Z^2pq/d^2$$

Substituting the above formula, we get n>56.6 i.e.; 57 (n=57). Allowing for some patients, non- cooperative with the study, the minimum sample size is taken as 60.

Methodology

It was a prospective randomized type of study.

Inclusion criteria

Patients aged 20-50 years, weighing 50-70 kg ASA 1 and ASA 2 grade were included.

Exclusion criteria

Patients with history of cardiac, respiratory, neuromuscular, hepatic and major renal diseases; obese patients; any contraindication for regional anesthesia such as skin infection over lumbar spine, elevated intracranial pressure, or severe kyphoscoliosis and failure of SA (inability to enter intrathecal space), coagulation disorders and any history of allergy to local anaesthetics (LA) were excluded.

Written informed consent was obtained from all patients. The study population was randomized into two groups as under- group S (n-30) receiving SA and group G (n-30) receiving GA.

Randomization

60 patients based on the inclusion and exclusion criteria were selected and allocated a serial number from 1 to 60. By using a computer-generated random number list the participants were allocated to either group.

The patients underwent postoperative assessment for pain, nausea and vomiting at 0.5 hour (T0.5), 1 hour (T1), 1.5 hours (T1.5), 2 hours (T2), 2.5 hours (T2.5) and 3 hours (T3) following surgery. All patients underwent preoperative assessment prior to surgery. Hemogram and urine analysis were done for all patients and other investigations were done preoperatively depending on the physical status, age and clinical profile of the patient. Standard institutional preoperative instructions were offered as per the hospital protocol. The patients were instructed on the use of the visual analogue scale (VAS 0-10) and numerical rating scale (NRS 0-4).

Patient to be kept NPO for 6 hours. All patients will receive pantoprazole 40 mg and alprazolam 0.5 mg on the day before and on the day of surgery and ondansetron 8 mg on the morning of surgery. After taking written informed consent patient is to be taken to operation theatre (OT) and routine monitoring will be started including electrocardiography (ECG) and SpO_2.

In SA, premedication of 0.01-0.02 mg/kg of midazolam was administered. The patients were placed in a sitting position. The drug was administered by a 25-gauge Quincke needle in midline of L3-L4 or L4-L5 level. For inducing SA, isobaric intra-thecal 3-3.5 ml of bupivacaine 0.5% was administered. 100% oxygen was administered. Sensory blockade was evaluated by a cotton peak (for heat perception) or a needle (for touching sense) every 15-20 seconds; then, motor blockade was tested by Bromage scale with following score: 0=no paralysis; 1=inability to raise extended leg; 2=inability to flex knee; and 3=inability

to move leg joints. Blood pressure below 100 mmHg or 30% from the baseline was corrected by 6 mg ephedrine and crystalloids, and all PR descents (less than 60/min) were treated by intravenous atropine. After placing urethral catheter in lithotomy position, patient was gently placed into prone position with assistance, then PCNL with fluoroscopy was done by standard technique.

In GA, patient was induced with propofol 2 mg/kg IV. Succinylcholine 1.5 mg/kg IV was given to facilitate tracheal intubation. After intubation patient was maintained with isoflurane 0.6-1% with 66% nitrous oxide in oxygen. Neuromuscular blockade was achieved using vecuronium 0.1 mg/kg IV. Heart rate, non-invasive blood pressure, arterial oxygen saturation, ends tidal carbon dioxide ($EtCO_2$) and three lead ECG were monitored. After placing urethral catheter in lithotomy position patient was gently placed into prone position with assistance, then PCNL with fluoroscopy was done by standard technique. Ondansetron 0.15 mg/kg IV was given 30 minutes before extubation. The residual neuromuscular blockade was antagonised with IV neostigmine 50 µg/kg and glycopyrrolate 8 µg/kg. After surgery, patients were observed in the postoperative room for thirty minutes and then shifted to their respective wards.

At 0.5 hour (T0.5), 1 hour (T1), 1.5 hours (T1.5), 2 hours (T2), 2.5 hours (T2.5) and 3 hours (T3), following surgery, level of postoperative pain was assessed using VAS (starting from 0-no pain to 10-worst pain imaginable). The level of postoperative nausea and vomiting was assessed with NRS. Starting from 0-no nausea, 1-nausea, 2-retching, 3- vomiting and 4-severe vomiting (4-5 episodes). In both the groups, rescue analgesia was given with injection pethidine 1 mg/kg and injection phenergan 0.5 mg/kg to patients with VAS scores of four or more. Ondansetron 0.1 mg/kg was given for anti-emesis to patients with NRS score of two or more in both the groups. The total required dosage of opioids and antiemetics were recorded for both groups. Postoperative complications observed: – PDPH, backache, limb weakness and/or neurological deficit.

Statistical analysis

The variables, age, height, weight, body mass index (BMI) and ASA are compared with respect to two groups, group S and group G. Independent sample t-test is used to compare the means. Error bars are also provided to show the variability of the data. All analyses are two–tailed and significance level is taken to be 0.05 (i.e., if the p value is less than 0.05, we reject the null hypothesis or we say that the hypothesis is statistically significant). Heart rate, mean blood pressure, Hb% of group S and group G were compared. Repeated measures are used to test VAS scores and NRS scores for different time periods are compared using independent t-test. The difference in the proportion of opioids and antiemetics consumption of group S and group G was tested. Z-test for proportion is used for this. Bar graphs are also added to show the proportion in each group. Statistical analysis was carried out using statistical package, statistical for the social sciences (SPSS) version 21.

RESULTS

The demographic characteristics i.e. age, height, weight, BMI and ASA of patients of group S and that of group G had no significant difference.

Comparison of heart rate

Heart rates of group S and group G were compared at 0^{th} min, 5^{th} min, 15^{th} min, 30^{th} min, 45^{th} min, 60^{th} min, 75^{th} min, 90^{th} min, 105^{th} min and 120^{th} min. We observed that heart rate at each time points of group-S and group-G have significant difference except at 120^{th} min. The multivariate test and profile plot show that the heart rate for different time points is significantly different but the heart rate for group S and group G have no significant difference.

Comparison of mean blood pressure

Mean blood pressure of group S and group G were compared at different time points, namely 0, 15, 30, 45, 60, 75, 90, 105, and 120. Mean blood pressure at each time points of group S and group G have significant difference except at time points of 30^{th} and 45^{th} minutes. Mean blood pressure within the group is significantly different but between the groups they have no significant difference.

Comparison of Hb%

Hb% of group S and group G were compared at different time points, namely pre-operation, post-operation (6 hours) and post-operation (24 hours). Our results are preoperative Hb% in group S is 13.67 mg/dl and in group G is 14.08 (p value=0.33), postoperative 6 hours Hb% in group S is 13.52 and in group G is 13.42 (p value=0.81), postoperative 24 hours Hb% in group S is 13.41 and in group G is 12.96 (p value=0.27). Hb% at each time points of group S and group G had significant difference.

Comparison of VAS scores

The sum of VAS scores was significantly different for both groups.

Comparison of opioids consumption and NRS scores

The NRS scores of both the groups group S and group G were compared. Observations were recorded at 0.5 hour (T0.5), 1 hour (T1), 1.5 hours (T1.5), 2 hours (T2), 2.5 hours (T2.5) and 3 hours (T3) postoperatively.

It was clearly observed that the group G had significantly higher NRS scores (mean NRS=6.566+) in comparison to group S (mean NRS=0.666+).

Opioids consumption in both group S and group G were compared. The opioids consumption in group S and group G were significantly different.

Comparison of antiemetics consumption

We used z-test for proportion to compare the antiemetics consumption. The antiemetics consumption in group S and group G were significantly different.

Postoperative complications of spinal anesthesia

Assessment was done during the postoperative period at 1st, 2nd and 3rd post-operative days. The patients were observed for the following postoperative complications – PDPH, backache, limb weakness and neurological deficit.

Among 30 patients who underwent SA for PCNL surgeries were observed for 3 consecutive post-operative days for any complications of SA. None of the patients had PDPH. Only 2 patients during 2nd postoperative day and 1 patient during 3rd postoperative day had mild backache which was managed conservatively. None of the patients had limb weakness or any neurological deficit.

From the Table 1, the demographic characteristics i.e., age, height, weight, body mass index (BMI) and ASA of patients of group S and of group G had no significant difference. Repeated measures are used for this analysis. Repeated measure tests the equality of means. It is used when the random sample is measured under a number of different conditions. In Tables 2 and 3, Wilks' Lambda gives the value.

Hb% of group S (patients receiving SA) and group G (patients receiving GA) were compared at different time points, namely pre-operation, post-operation (6 hours) and post-operation (24 hours). We can see that the Hb% at each time points of group S (patients receiving SA) and group G (patients receiving GA) have significant difference (Table 4).

Opioids consumption in both group S and group G were compared. Here we have used the z-test for proportion to compare the opioids consumption. Number of patients who consumed opioids in group S is 12/30 and in group G was 26/30 (Table 5). Hence, it can be concluded that opioids consumption in group S (patients receiving SA) and group G (patients receiving GA) are significantly different.

Table 1: Demographics.

Demographics	Mean		Standard deviation		T test	df	P value
	Group S	Group G	Group S	Group G			
Age	40.6	43.63	6.73	6.74	-1.74*	58	0.09
Height	163.8	161.83	5.4	5.93	1.34*	58	0.18
Weight	64	63	5.75	5.55	0.69*	58	0.5
BMI	23.87	24.13	2.31	2.75	-0.41*	58	0.69
ASA grade	1.23	1.23	0.43	0.43	0*	58	1

*Significant at 5%; **significant at 1%

Table 2: Multivariate analysis for heart rate.

Effect	Value	P value
HR	0.502	0**
HR* group	0.813	0.273

*Significant at 5%; **significant at 1%

Table 3: Multivariate analysis for MBP.

Effect	Value	P value
MBP	0.38	0**
MBP* group	0.88	0.44

Table 4: Comparison of Hb%.

Hb%	Mean		SD		t test	Df	P value
	Group S	Group G	Group S	Group G			
Pre op	13.67	14.08	1.8	1.42	-0.99	58	0.33
Post op (6 hours)	13.52	13.42	1.7	1.42	0.24	58	0.81
Post op (24 hours)	13.41	12.96	1.66	1.46	1.11	58	0.27

*Significant at 5%; **significant at 1%

Table 5: Test for proportion-opioids consumption.

Two-tail test	
Lower critical value	-1.96
Upper critical value	1.96
P value	0

Table 6: Test for proportion-antiemetic consumption.

Two-tail test	
Lower critical value	-1.96
Upper critical value	1.96
P value	0

Number of patients who consumed antiemetics in group S is 2/30 and in group G was 22/30. The antiemetics consumption in group S and group G were significantly different.

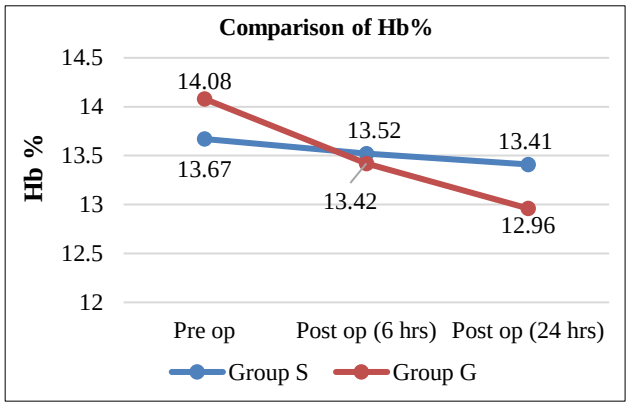

Figure 1: Profile plot for Hb%.

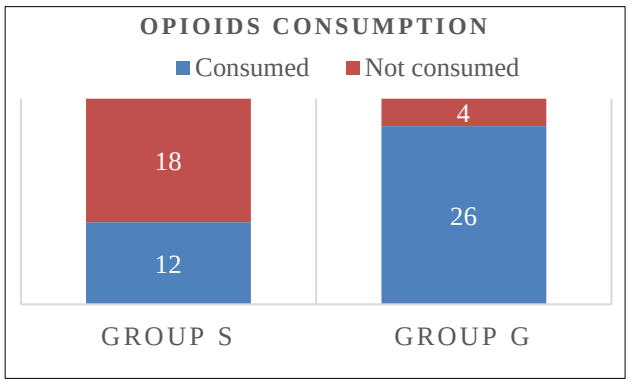

Figure 2: Proportion of patients given opioids.

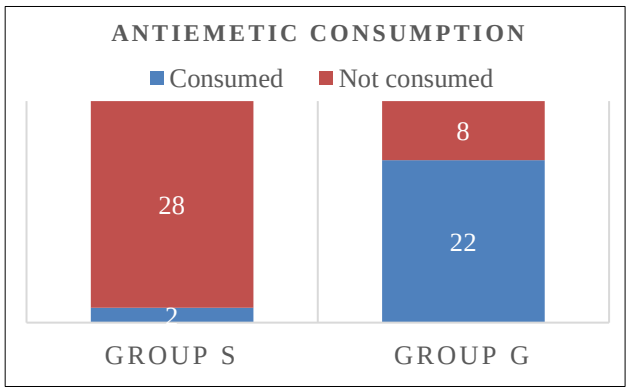

Figure 3: Proportion of patients given antiemetics.

DISCUSSION

Percutaneous nephrolithotomy is a minimally invasive surgery which is accepted for treating large renal and upper ureteric calculi. It is used for the fragmentation and removal of large or multiple calculi from the renal pelvis and renal caliceal systems. It has been shown that PCNL under assisted LA is safe and effective in selected patients. GA is currently the standard technique used for percutaneous nephrolithotomy surgeries. GA can be a challenge in some situations such as PCNL for staghorn calculi, because of the possibility of fluid absorption and electrolyte imbalance. Therefore, regional anesthesia may be a good alternative.[13]

The advantages of SA compared to GA were also demonstrated in other procedures such as radical retropubic prostatectomy and unilateral total hip arthroplasty.[14,15] PCNL under regional spinal anesthesia was reported to gain benefits because regional anesthesia achieves better postoperative quality of life due to earlier postoperative recovery but most reports were not part of the controlled study. SA is a commonly employed anaesthetic technique for performing lower limb/abdominal surgeries. It is a safe, inexpensive and easy-to administer technique which also offers a high level of post anesthesia satisfaction for patients. The technique is simple, has rapid onset and is reliable. The risk of GA, including mishaps due to airway management, aspiration and poly pharmacy are avoided.

This study was under taken in Lisie Hospital, Ernakulam, Kerala. Sixty patients scheduled for percutaneous nephrolithotomy surgeries were enrolled in this study. After obtaining written informed consent from the patients and approval of the hospital ethical committee, they were randomized into two groups – group S and group G. The demographic data when statistically analysed showed no statistically significant differences between the groups with respect to the age, sex, weight, ASA physical status grading and the procedure performed. The groups were therefore comparable.

In our study, heart rates and mean blood pressures of group S and group G were compared every 15 minutes up to 120 minutes. We observed that heart rate at each time points of group S and group G have significant difference except at 120th min. The multivariate test and profile plot show that the heart rate for different time points is significantly different but the heart rate for group S and group G have no significant difference. Mean blood pressure at each time points of group S and group G have significant difference except at time points of 30th and 45th minutes. Mean blood pressure within the group is significantly different but between the groups they have no significant difference. Overall, our study demonstrated that mean blood pressure (MBP) and heart rate (HR) did not have any significant difference between 2 groups, and that the trend was also somewhat similar in SA and GA; however, patients' hemodynamics were more stable in SA group. The results in our study correlate with the results in a study done by Gholamreza Movassegh et al.[16] In this study, mean arterial pressure (MAP), and HR were recorded every 20 minutes during surgery from the beginning of anesthesia. Systolic blood pressure (SBP), diastolic blood pressure (DBP), MAP, and HR were recorded in the post-anesthesia care unit (PACU), every 10 min from entering PACU for 1 hour. SBP was significantly lower in GA

group only in 120th minute; DBP in 60th, 90th, and 120th minutes, and MAP in 90th and 120th minutes ($p<0.05$). They demonstrated that SBP, DBP, MAP, and HR in the whole surgery and recovery times did not have any significant difference between 2 groups, and that the trend was also somewhat similar in SA and GA. In PACU, SBP was significantly lower in 10th, 20th, 30th and 40th minute; DBP and MAP in all evaluations and HR only in the 20th minutes were lower ($p<0.05$). These results were also similar to previous studies demonstrating that SA group had better hemodynamics and lower bleeding during and after the surgery.[17]

In our study, mean values of Hb% of group S and group G were compared at different time points, namely pre-operation, post-operation (6 hours) and post-operation (24 hours). Hb% at each time points of group S and group G had significant difference and it was significantly lower in group G. In contrast to the results in our study, a study was done for PCNL surgeries by Tangpaitoon et al, where pre-operative and post-operative 24 hours Hb% and Hct values are compared between SA and GA.[18] In their study, preoperative Hb (mg/dl) in SA is 13.13 mg/dl and in GA is 13.38 mg/dl (p value=0.648). Post-operative 24 hours Hb values in SA group is 11.13 mg/dl and in GA is 11.45 mg/dl (p value=0.552). Preoperative hematocrit (Hct) in SA group is 40.05 and in GA is 40.06 (p value=0.992). Postoperative 24 hours Hct values in SA is 33.66 and in GA is 34.88 (p value=0.456). They concluded that preoperative and postoperative haemoglobin and Hct were no different between the two groups.

In our study, patients were asked to use the VAS (0-10) to evaluate their pain postoperatively. VAS scores were recorded on 0.5 hour (T0.5), 1 hour (T1), 1.5 hours (T1.5), 2 hours (T2), 2.5 hours (T2.5) and 3 hours (T3) postoperatively. The follow up revealed that patients receiving SA had low VAS scores for pain in comparison to patients receiving GA. VAS scores of group S was found to be considerably lower (mean VAS=3.4) than group G (mean VAS=9.4). The results in our study correlate with the studies conducted by Tangpaitoon et al.[18] In the study conducted by Tangpaitoon et al, patients with epidural anesthesia (group 2) needed smaller amounts of postoperative analgesic drug. A reduced VAS score in regional epidural anesthesia was found at 1 hour and 4 hours postoperatively. Patients who underwent PCNL with GA (group 1) received more analgesic drugs. Average pain score at 1 hour was 6.88 in group 1 and 3.12 in group 2 ($p<0.001$), at 4 hours -5.07 in group 1 and 3.42 in group 2 ($p=0.025$).

In our study, VAS score was used as the parameter for determining the requirement of rescue analgesia. In our study 12 patients out of 30 patients in group S consumed opioids and in group G 26 patients out of 30 patients consumed opioids. Group G was found to have a significantly greater consumption of opioids during the postoperative period in comparison to group S. Regarding dose of narcotic drugs after surgery and postoperative complications, results in our study are similar to study conducted by Andreoni et al. Andreoni et al reported the positive effect of a preoperative single dose of subarachnoid SA associated with GA (group A) in 9 patients who were treated by PCNL, compared to 11 patients who underwent GA alone (group B).[19] In group A, the average pain score on D0, D1, and D2 was 2.7, 3.7, and 1.4, respectively; in group B, the average pain score was 4, 4.5, and 2, respectively ($p>0.05$).

In our study, among 30 patients in group S, 2 patients had PONV. In 30 patients among group G, 22 patients had PONV. It was observed that the group G had significantly higher NRS scores (mean NRS=6.566+) in comparison to group S (mean NRS=0.666+). The results in our study correlate with a study conducted by Tangpaitoon et al, where among 26 patients in GA group, 6 patients had PONV. Among 24 patients in regional epidural anesthesia group, 1 patient had PONV (p value=0.05).

In our study, among 30 patients who underwent SA for PCNL surgeries were observed for 3 consecutive post-operative days for any complications of SA. None of the patients had PDPH. Only 2 patients during 2nd postoperative day and 1 patient during 3rd postoperative day had mild backache which was managed conservatively. None of the patients had limb weakness or any neurological deficit. The results are almost similar to studies done by Meharbi et al, where they evaluated 160 patients who underwent PCNL under SA in prone position. 6 patients complained of mild to moderate headache, dizziness, and mild postoperative low back pain for 2 to 4 days. Finally, authors suggested SA as a safe, effective, and cost-effective method in adult PCNL.

Limitations

Limitations of the study was that only ASA 1 and 2 patients were included in the study. Also, it was not a blinded study because we needed to take consent for type of anesthesia provided and hence, we could not blind the patient or the operator.

CONCLUSION

In our study we can say that there are some advantages of SA group over GA including less nausea and vomiting, less postoperative pain, less opioid consumption, reduced amount of blood loss. There were minor complications like mild backache in few patients during postoperative period which were managed conservatively. Hence, we concluded that SA is safe and effective method as an alternative method for PCNL surgeries.

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