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Research Article

A comparative study of combined spinal epidural anaesthesia and general anaesthesia in patients undergoing percutaneous nephrolithotomy

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ABSTRACT

Background: Our primary aim was to study the efficacy, safety, hemodynamic stability, postoperative pain relief, and complication with combined spinal epidural anaesthesia (CSE) and to compare it with general anaesthesia (GA) for percutaneous nephrolithotomy (PCNL).
Methods: The present study was a prospective, randomized, open, controlled trial to compare the effects of CSE and GA in patients undergoing PCNL. Study was carried out in 100 adult patients, who were randomly divided into two groups of 50 each, Group GA and Group CSE. Post-operative pain relief and amount rescue analgesia required were noted. Postoperatively samples were collected for haemoglobin and arterial blood gases. Incidence of complications were noted and compared among both the groups.
Results: Mean arterial pressure in CSE group was less compared to GA group during the procedure. 30 % patients in group GA required first rescue analgesia within first hour of completion of surgery whereas no patient in group CSE required analgesia within first hour indicating better pain relief in CSE group. Mean haemoglobin and the fall in haemoglobin between the groups were comparable. 48.0% of the cases among GA group and 14.0% of the cases among CSE group had postoperative nausea and vomiting. Mean pH in GA group was 7.33±0.05 and in CSE group was 7.36±0.04. There was one case of hydrothorax post operatively.
Conclusions: We conclude that CSE is a safe alternative to GA for PCNL with better pain relief, less PONV. Hypotension due to sympathetic blockade is always a possibility.

Keywords: Percutaneous nephrolithotomy, Spinal epidural anaesthesia, Hypotension, Postoperative nausea and vomiting, Post-operative pain

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is a minimally invasive endoscopic technique & the treatment of choice for renal calculi larger than 20-30 mm, staghorn stones and stones that are multiple or resistant to extra corporeal shock wave lithotripsy.[1,2]

Traditionally, most urologists and anesthesiologists prefer GA for PCNL due to patient comfort, and a high dermatomal level of anaesthesia required.[3] However, GA has potential complications like adverse drug reactions, endotracheal tube movement, aspiration of gastric contents, pulmonary atelectasis, vascular damage, neurological disorder and cardiopulmonary complication.[4-6]

The first description of PCNL under regional anaesthesia was reported by Peterson GN et al in 1985.[6] Few studies indicate that the regional anaesthesia is a suitable

alternative to GA in PCNL.[7-15] Since surgery is performed in the prone position, in regional anaesthesia the management of respiratory depression or administration of general anaesthesia is difficult. It may become problematic for the anaesthetist to resolve pain and to keep the patient calm & comfortable during the procedure.

Our primary aim was to study the efficacy, safety, hemodynamic stability, postoperative pain relief, and complication with CSE and to compare it with GA for PCNL.

METHODS

The present study was a prospective, randomized, open, controlled trial to compare the effects of CSE and GA in patients undergoing PCNL surgery. Study was carried out from April 2012 to April 2013 in 100 adult patients of either sex, of ASA grade I & II, between the age group of 18 to 65 years after obtaining approval from Institutional Ethics Committee. Non consenting patients, patients with ASA grade ≥3, coagulopathy, neuropathy, vertebral deformity, metabolic acidosis, BMI>30; patients with contraindications for CSE were excluded from the study.

Thorough preoperative assessment was carried out, all relevant investigations were noted. Patients fulfilling the inclusion criteria were explained about the study. An informed and written consent was obtained from those who were willing to participate in the study. The patients were randomly divided into two groups of 50 each, Group GA and Group CSE by computerized generated randomized table.

After confirming adequate starvation, inside the operation theatre, a cardioscope, a pulse oximeter and a noninvasive blood pressure cuff were attached to the patients and baseline values for heart rate, mean arterial blood pressure (MAP) and peripheral oxygen saturation (Sp02) were recorded. An intravenous access was secured using 20 gauge indwelling cannula in upper limb.

All the patients were premedicated with Inj. Atropine 0.01 mg/kg (given intramuscularly half an hour prior to surgery), Inj. Ranitidine 1 mg/kg, Inj. Ondansetron 0.08 mg/kg intravenously. In group GA Inj. Midazolam 0.02 mg/kg and Inj. Pentazocine 0.6 mg/kg was also given as premedication. All the patients were preloaded with 5 ml/kg of crystalloid. Then the patients of group GA were preoxygenated and anaesthesia was induced with Inj. Thiopentone sodium 3-5 mg/kg in graded doses. Neuromuscular blockade was achieved with Inj. Vecuronium 0.1 mg/kg. Intubation was performed with appropriate sized endotracheal tube. Anaesthesia was maintained on 60% nitrous oxide in oxygen, intermittent vecuronium and propofol infusion titrated to maintain heart rate and blood pressure ±20% of baseline. At the end of the surgery patients were reversed with Inj. Glycopyrrolate 0.008 mg/kg and Inj. Neostigmine 0.06 mg/kg. Extubation was performed when patient obeyed verbal commands and had good muscle power. After extubation, the vital parameters were recorded and then patients were shifted to recovery room.

After preloading in group CSE, epidural catheter was inserted in L2-L3 space with the catheter inserted 5cm in upwards direction under all aseptic precautions, following which subarachnoid block was given in a space below using 25 gauge spinal needle. Inj. Bupivacaine 0.5 % heavy was given to achieve a sensory level of T6. After every 2 segment regression, epidural top up was given with Inj. Bupivacaine 0.5% to maintain a level of T6.

Ureteric catheterization was done in the lithotomy position. Following this patients were made supine and were log rolled into the prone position.

All patients were monitored intra operatively in terms of heart rate, MAP, oxygen saturation every five minutes for first twenty minutes, every ten minutes for the next sixty minutes and every twenty minutes thereafter. Any episode of hypotension (>30% fall in systolic blood pressure), hypertension (>30% rise in systolic blood pressure), tachycardia (heart rate >100/minute), bradycardia (heart rate <60/minute), desaturation was noted. Hypotension was corrected by a bolus 250 ml intravenous fluids and Inj. Ephedrine in incremental doses. Proseal LMA was kept ready in case intermittent positive pressure ventilation was required.

The standard operative technique of PCNL consists of four main steps:[16]

1. Insertion of ureteric catheter was done in lithotomy position, to dilate the pelvicalyceal system (PCS) and to delineate it.

2. Percutaneous puncture of PCS is done under fluoroscopic guidance.

3. *Development of track*: The next step is to dilate a track from the skin through the renal parenchyma into the collecting system, and to place a working sheath.

4. *Fragmentation and removal of stone:* The stone is fragmented with pneumatic/ultrasonic/laser lithoclast and the fragments are extracted with the help of forceps. Continuous irrigation with warm normal saline is required for clear visibility. After complete clearance the ureteric catheter is removed and a double J stent is inserted if needed.

Post operatively, patients were monitored for two hours in post anaesthesia care unit. Arterial blood gas (ABG) was sent in all patients. Post-operative pain relief (requirement of first rescue analgesia) was noted and pain

relief was given as and when the visual analogue score ≥4, with Inj. Paracetamol 15 mg/kg intravenously.

Post operatively after 24 hours samples were collected for haemoglobin. Incidence of complications were noted and compared among both the groups.

Statistical analysis

Data was analyzed using software version SPSS 12.0 (SPSS Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL 60606- 6412). For each parameter mean and standard deviation were calculated and statistically analysed using Chi-square test and Student 't' test wherever appropriate. For all statistical comparisons, P<0.05 was taken as significant.

RESULTS

The present study was conducted on ASA I-II patients undergoing PCNL to see for the efficacy of performing the same under CSE anaesthesia. Hundred patients were randomly allocated into two groups: Group GA & Group CSE.

The two groups were comparable with respect to age, weight, height, sex, duration of surgery, puncture site and mean stone size (Table 1).

Table 2 shows Intraoperative heart rate in both the groups. In group GA there was a significant increase in heart rate which coincided with the intubation response for first ten minutes.

Table 1: Demographic & patient characteristics.

Parameters	GA Grp Mean±SD	CSE Grp Mean±SD	P value
Age (yrs)@	43.92 ± 11.12	40.54± 11.41	p>0.05
Weight (kg)@	57.54 ± 05.12	58.26± 05.32	p>0.05
Height (cm)@	162.3 ± 07.93	162.4± 06.62	p>0.05
Sex (M:F)#	32 :18	38 :12	p>0.05
Duration of surgery (min) @	146.4± 23.80	142.80± 27.48	0.4855
Mean stone size (cm) @	2.59± 0.39	2.49± 0.42	0.2203
Supracostal puncture#	6	5	p>0.05
Subcostal puncture	44	45	p>0.05

@ by Student 't' Test, # by Chi–Square Test; p > 0.05 Not Significant

Table 2: Intraoperative heart rate.

Time(minutes)	GA			CSE			'p' Value
	Mean	SD	'P' value	Mean	SD	'P' value	Unpaired 't' test
BI	86.06	7.38		86.96	8.44		0.57
0 min	93.80	8.46	0.000*	90.76	10.11	0.000*	0.11
5 min	91.46	7.73	0.000*	95.46	10.91	0.000*	0.04*
10 min	89.94	8.06	0.000*	91.70	10.74	0.000*	0.36
15 min	88.44	8.72	0.10	88.68	9.03	0.11	0.89
20 min	86.74	8.55	0.64	87.22	8.09	0.80	0.77
40 min	86.16	7.64	0.95	85.32	8.81	0.18	0.61
60 min	84.92	7.59	0.49	85.06	6.63	0.10	0.92
80 min	84.88	6.31	0.36	84.10	6.85	0.01*	0.30
120 min£	84.81	5.47	0.22	83.64	7.19	0.000*	0.37
160 min^	85.92	8.02	0.97	85.57	6.06	0.09	0.87
180 min$	90.00	5.54	0.03*	86.33	6.24	0.18	0.24

*p < 0.05 Significant; £, ^ and $ number of observations are (48 & 47), (24 & 23) and (7 & 9) respectively (both groups)

As seen in Table 3, in group GA, there was a rise in MAP during intubation (at 0 minutes) which returned to near the baseline after ten minutes. As compared to group GA, the MAP in CSE group was significantly less during the procedure. Only three patients had transient hypotension which was treated successfully.

As seen in Table 4, SpO_2 was comparable between the two groups. Table 5 shows requirement of epidural top ups and rescue analgesia. Twenty eight patients belonging to group CSE, underwent the surgical procedure without requiring supplementary epidural doses, whereas fifteen patients required two epidural top ups and seven patients required only one top up. 30 % patients in group GA required first rescue analgesia within first hour of completion of surgery whereas no patient in group CSE required analgesia within first hour. Hence indicates a better pain relief in CSE group.

As per Table 6 mean haemoglobin pre and post operatively and the fall in haemoglobin between the groups was comparable and none of the patients required blood transfusion. Postoperative complications are shown in table7. 48.0% of the total cases among GA group had postoperative nausea and vomiting (PONV) which was significantly more as compared to 14.0% of the cases among CSE group. Mean pH in GA group was 7.33 and in CSE group was 7.36 where difference between the group was statistically significant but no clinically significant acidosis was seen. There was one case of hydrothorax post operatively which required intercostal chest tube drainage.

Table 3: Intraoperative mean arterial pressure.

Time (minutes)	GA			CSE			p value
	Mean	SD	Paired p value	Mean	SD	Paired p value	Unpaired p value
BI	96.73	7.29		94.82	6.59		0.17
0 min	102.66	9.83	0.000*	94.43	7.76	0.46	0.00*
5 min	98.54	6.42	0.08	83.94	9.07	0.000*	0.00*
10 min	95.46	6.01	0.23	83.94	7.24	0.000*	0.00*
15 min	93.54	6.37	0.000*	85.00	6.60	0.000*	0.00*
20 min	90.08	6.75	0.000*	85.04	6.28	0.000*	0.00*
40 min	91.29	7.79	0.000*	86.30	6.01	0.000*	0.00*
60 min	89.42	7.28	0.000*	86.33	6.27	0.000*	0.03*
80 min	89.86	8.05	0.000*	86.90	5.85	0.000*	0.04*
120 min£	89.66	9.51	0.33	87.45	5.60	0.000*	0.32
160 min^	92.74	8.63	0.25	89.98	6.28	0.000*	0.22
180 min$	99.53	7.51	0.04*	86.41	3.46	0.000*	0.00*

* P < 0.05 Significant; £, ^ and $ number of observations are 48, (25 & 23) and 7 respectively (both groups).

Table 4: Trend of intraoperative SpO_2.

Duration in minutes	Mean SpO_2 (Mean ± SD)			
	N	GA	N	CSE
Baseline	50	99.12 ±00.33	50	99.08 ±00.00
0	50	99.06 ±00.24	50	99.04 ±00.20
5	50	99.04 ±00.20	50	99.00 ±00.00
10	50	99.02 ±00.14	50	99.06 ±00.24
15	50	99.04 ±00.20	50	99.08 ±00.27
20	50	99.04 ±00.20	50	99.04 ±00.20
40	50	99.00 ±00.00	50	99.00 ±00.00
60	50	99.02 ±00.14	50	99.02 ±00.14
80	50	99.02 ±00.38	50	99.04 ±00.20
120	47	99.00 ±00.00	49	98.96 ±00.29
160	26	99.00 ±00.00	23	99.00 ±00.00
180	07	99.00 ±00.00	11	99.00 ±00.00

ANOVA, p > 0.05 Not Significant

Table 5: Profile of supplementary epidural top up in CSE and amount of rescue analgesia required.

Epidural top up in CSE		Rescue analgesia required				
Number of epidural top up	No of patients (%)	No of Hours	GA		CSE	
			No	%	No	%
3	0	0	05	10.0	-	-
2	15 (30%)	1	10	20.0	-	-
1	7 (14%)	2	*27	54.0	15	30.0
0	28 (56%)	3	*08	16.0	35	70.0

By Chi Square test * p <0.05 Significant.

Table 6: Comparison of haemoglobin-pre and post operatively.

	Mean Haemoglobin (Mean± SD) (g/dl)		P value
	GA	CSE	
Pre op	11.81±1.55	11.97±1.11	0.569
Post op	11.23±1.29	11.40±0.96	0.466
Pre-Post	0.58 ±0.52	0.86±1.27	0.159

By Student 't' test, p > 0.05 Not Significant

Table 7: Post-operative complications.

Types of complication		GA	CSE	P value
PONV	Yes Number (%)	*24 (48.0%)	7 (14.0%)	p<0.05
	No Number (%)	*26 (52.0%)	43 (86.0%)	
Acidosis	Ph (Mean±SD)	07.33±00.05	07.36±00.04	0.00#
	Bicarbonate (Mean±SD)	22.01±2.71	23.70±8.62	0.19
Pleural injury		1	-	

By *Chi Square test, # By student 't' test * p < 0.05 Significant.

DISCUSSION

GA is the gold standard technique to perform PCNL surgery in prone position. We carried out this prospective, randomized, open, controlled trial to evaluate the efficacy, safety of performing PCNL surgery under regional anaesthesia (RA) as compared to GA.

This study was carried out in 100 adult patients undergoing PCNL, fifty in each group. As seen in table 1 demographic detail of the patients between the two groups were comparable.

Duration of surgery: the mean duration of surgery in group GA was 146.4+23.80 minutes and in group CSE was 142.80+27.48 minutes. The maximum duration of surgery was 180 minutes. Prolonged operative time can lead to hypothermia, metabolic acidosis, also can cause pressure related injuries. A case of posterior ischemic optic neuropathy following PCNL under GA has been reported by Pakravan M et al in 2007.[17] None of our patients developed any complication due to prolonged prone position.

Stone size was comparable in both the groups. The mean stone size in GA group was 2.59±0.39 cm and in CSE group was 2.49±0.42 cm. 6 cases in group GA and 5 cases in group CSE had staghorn calculus. Complex and staghorn calculi with multiple calyceal involvement often require multiple tracts to achieve better clearance.

Haemodynamics

Haemodynamic changes during PCNL can be due to various factors such as type of anaesthesia (GA/CSE), positioning, fluid absorption, co-morbidity of the patient and blood loss. Hypotension and bradycardia have been encountered in several studies where PCNL was done under spinal or epidural anaesthesia. Movasseghi et al found no significant differences in MAP and heart rate (HR) during surgery and recovery, between the spinal anaesthesia (SA) and GA groups, but hemodynamics were more stable in the SA group.[10] Mehrabi S et al in their study reported hypotension in 11 cases in SA group while in 2 cases in GA group.[11] In study done by Singh et al in, hemodynamic instability was observed in 3 patients in the CSE group and 2 patients in the GA group, which was insignificant on statistical analysis.[18] Mehrabi et al in 2011 evaluated 160 consecutive patients who underwent PCNL under SA.[19] They reported hypotension in 18 patients, 3 to 10 minutes after RA that was controlled by injecting 10 mg ephedrine intravenously. Karacalar Serap et al conducted a prospective study on 180 patients undergoing PCNL under GA and CSE and concluded that haemodynamics were comparable in both the groups.[20] Eighteen patients in CSE group had hypotension which responded to phenylephrine. Eleven patients in the GA group had hypotension however this group did not require phenylephrine. The incidence of bradycardia was similar in both the groups. Elbealy et al also found that the MAP was significantly lower in the RA group compared with GA group from 15 to 90 min after anaesthesia ($p < 0.05$).[21] In 2006, Vorrakitpokatorn P et al conducted a study on 128 patients undergoing PCNL under GA and found out that about 27.7% patients developed hypotension and 29% patients developed hypertension which correlated well with the amount of irrigation fluid absorbed and concluded that volume of irrigation fluid when greater than 20 liters correlates with cardiovascular changes seen and incidence of hypothermia.[22] A case of sudden cardiac arrest during

PCNL under epidural anaesthesia was reported in a 52 year old male with successful resuscitation.[23]

CSE technique implemented for PCNL procedure necessitated a regional block of up to T6 segment. This high level of block can predispose the patient to bradycardia and hypotension.

In our study, the haemodynamics were stable in both the groups, as all the patients were preloaded with 5 ml/kg of crystalloid and Inj. Atropine was given as premedication. There was an initial significant rise in heart rate and blood pressure in GA group which coincided with intubation response, and responded to deepening the plane of anaesthesia. After induction a statistically significant fall in MAP was noted in CSE group associated with a momentary rise in heart rate. However this was not clinically significant. Only 3 patients developed clinically significant hypotension. They responded immediately to a 250 ml bolus of intravenous fluid and a single dose (6 mg) of ephedrine. None of our patients had bradycardia. Over all as compared to group GA, the MAP in CSE group was less during the procedure, which was only statistically significant but clinically the patients were stable.

Epidural top up and postoperative pain relief

22 patients required supplementary epidural doses during the procedure (44 %) and the remaining 28 patients didn't require any top ups (Table 5). This is the advantage of having an epidural catheter that allows supplementary epidural doses which helps to increase the block level and prolongs the analgesia time during longer PCNL procedures. Epidural anaesthesia causes sensory, motor and sympathetic block but still during the surgery the proprioception may not be blocked. This may make the patients anxious and may decrease the patient's compliance. In our study we encountered five patients in group CSE complained of discomfort during the surgery which was tackled by confirming the sensory level and reassuring the patient. Studies have been conducted in patients undergoing PCNL under RA where conscious sedation has been given safely, keeping in mind about the difficulty in ventilation in prone position.[24]

Postoperative pain

In our study, pain relief was better in CSE group as compared to GA as evidenced by the time requirement of first rescue analgesia. 30% of patients in group GA required rescue analgesia within first hour of postoperative period whereas no patient in CSE group required analgesia within first hour. 70% of patients in group CSE required rescue analgesia at 3 hours whereas most of the patients in GA group required rescue analgesia within first 2 hours (Table 5).

Similar to our study Mehrabi S et al, Nouralizadeh A et al, Tangpaitoon et al, Singh et al found lower VAS scores and less amount of narcotic required in RA group on the day of surgery compared to GA group difference being statistically significant ($p < 0.05$).[11,18,25,26,28] Karacalar Serap et al studied 180 patients undergoing PCNL, concluded that CSE gave greater patient satisfaction, shorter times for PACU and home readiness, and less postoperative pain ($p = 0.001$).[20] Elbeally et al conducted a study on 57 patients undergoing PCNL in GA, epidural anaesthesia (EA) and paravertebral block (P).[21] They concluded that pain relief was better in epidural and paravertebral group as compared to GA group.

Blood loss

The bleeding during PCNL occurs due to damage to renal vessel during access to the PCS and intrarenal manipulations.[27] Multiple access tracts, staghorn calculi, presence of diabetes and prolonged operative time, but not surgical experience, significantly increased blood loss during PCNL.[28]

In our study, the mean fall of haemoglobin in group GA was 0.58±0.52 g/dl and in CSE was 0.86±1.27 g/dl, which was not significant and none of the patients required blood transfusion (Table 6). Similarly Kuzgunbay et al, Mehrabi et al, Vorrakitpokatorn et al also found a fall in the haemoglobin postoperatively.[5,19,22]

PONV

PONV significantly influences readiness for discharge from a hospital. Volatile anesthetics, nitrous oxide, and opioids appear to be the most important causes for PONV.[29] In our study 48% of patients in GA group had PONV whereas only 14% of patients had PONV in CSE group which was statistically significant (Table 7). Similar to our study Tangpaitoon et al, Karacalar Serap et al, Elbealy et al found increase in incidence of PONV in GA group as compared to CSE.[20, 21, 26]

Acidosis

We also compared postoperative ABG to know the incidence of acidosis in both the groups and found out that the mean pH was statistically lower in group GA with a mean of 07.33+00.05 than in group CSE with mean of 07.36+00.04, however we didn't find any clinically significant acidosis in either group. Acidosis in patients undergoing PCNL can occur due to their basic disease process, intraoperative hypothermia and hypotension. Mohta et al found no significant changes in hemodynamic and electrolytes, but there was a trend towards metabolic acidosis.[30] Atici et al conducted a study to investigate the hormonal and hemodynamic changes during PCNL and concluded that there is a tendency towards hyponatremia and metabolic acidosis, in addition to significant increases in renin, aldosterone and ACTH levels during procedures.[31] Hence arterial blood gases should be monitored during and after PCNL surgeries in cases with prolonged irrigation time, repeated

percutaneous interventions and patients having compromised renal function and metabolic status.

Pleural injury leading to hydrothorax was seen in one case postoperatively which required intercostal chest tube drainage further course of the patient was uneventful. In our study, most of the punctures were sub costal barring 6 patients in group GA and 5 patients in group CSE who required supra costal puncture for effective clearance of stones. When supra 11th rib access is performed, the incidence of intrathoracic complications increases to 23.1% versus 1.5% to 12% with above-12th rib approach and 0.5% for subcostal access.[32] In a study by Mousavi-Bahar SH et al found rate of pleural injury was 0.7% (5 subjects, 2 hemothorax and 3 hydrothorax), which occurred only with the supracostal access.[33] The working sheath should be inserted under the 11th rib or above the 12th rib in the "lung down" position to prevent such complications. R Gupta et al did a prospective study to evaluate the safety and efficacy of supra costal puncture in patients undergoing PCNL and concluded that supra costal approach provides high clearance rates with acceptable complications.[34] 5% patients developed significant chest complications which required chest tube placement and 2% developed haemothorax secondary to injury to intercostal artery. Hence intraoperative monitoring of saturation by pulse oximeter, airway pressure, $EtCO_2$ and frequent auscultation of lungs is of paramount importance during the surgery. These parameters were stable in our study (Table 4). A chest radiograph in the recovery room is recommended after every PCNL. Fluoroscopic monitoring of the chest during the procedure is a sensitive means for the timely diagnosis of pneumothorax and hydrothorax.

Other complications such as renal parenchymal injury, fever, colon perforation, major vessels injury, contiguous organ injuries, hypothermia, electrolyte disturbances, fluid overload, sepsis, stricture formation, nephrocutaneous fistula, renal loss were not seen in our study.[14, 33-38]

CONCLUSION

We conclude that CSE is a safe alternative to GA for PCNL. Haemodynamic were stable, positioning was easy, PONV was less, and postoperative pain relief was better in the CSE group as compared to GA group. However this technique has to be used judiciously in patients with co morbidities and with a large stone load. Hypotension due to sympathetic blockade is always a possibility and patient cooperation due to long surgical time has to be tackled. There are chances of injury to pleura, hence continuous monitoring of saturation, airway pressure, EtCO2 and frequent auscultation of lungs is of paramount importance during the surgery.

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