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SEGMENTAL SPINAL ANAESTHESIA FOR PCNL SURGERIES WITH 0.5% ISOBARIC LEVOBUPIVACAINE-FENTANYL & 0.5% HYPERBARIC BUPIVACAINE: A CASE SERIES

Anaesthesiology

Shaikh R. F. Junior Resident, Dept Of Anaesthesiology, Iimsr Warudi, Badnapur, Jalna

Deshmukh S D* Assistant Professor, Dept Of Anaesthesiology, Iimsr Warudi, Badnapur, Jalna *Corresponding Author

Lonikar M Prof & Hod, Dept Of Anaesthesiology, Iimsr Warudi, Badnapur, Jalna

Godhane Ar Dept Of Anaesthesiology, Iimsr Warudi, Badnapur, Jalna

ABSTRACT

Introduction: Percutaneous Nephrolithotomy (PCNL) is the treatment modality used for the extraction of large renal stones or multiple calculi or stones resistant to shock wave lithotripsy. The General Anaesthesia (GA) is the standard modality for PCNL. However, few studies conclude that Segmental Spinal Anaesthesia (SSA) can be an alternative method of anaesthesia with similar incidence of complications. **Objective:** In our case series we evaluated the feasibility of segmental spinal anaesthesia in terms to provide comprehensive review of SSA in PCNL patients, focusing on its benefits, technique, clinical outcomes and challenges. **Materials and methods:** After complete pre-anaesthetic evaluation, ten patients having renal calculi were selected randomly between the age group of 18-60years. Three patients were known cases of hypertension, four patients had DM with HTN & three were without any co-morbidities all were under ASAI/II. There was no preference to gender, size, location and laterality of stone or BMI. All the patients fit into the American urological association guideline criteria for management by percutaneous nephrolithotomy. For SSA 0.5% isobaric levobupivacaine 1.2 ml with 30mcg fentanyl as adjuvant & 0.5 ml of 0.5% hyperbaric bupivacaine (total volume of 2ml) was given in T10-T11 intervertebral space targeting the desired spinal segments. **Results:** effect of SSA was satisfactory in all the cases to complete the surgery. Out of total 10 patients, two patients required vasopressors due to hypotension after segmental spinal anesthesia. Rest of the patients were haemodynamically stable throughout the surgery. **Conclusion:** SSA was well tolerated in patients undergoing PCNL surgery. It provides an additional benefit as compared to conventional spinal anaesthesia, which is enhanced pain control, reduced systemic effects & improved hemodynamic stability in patients undergoing PCNL surgery.

KEYWORDS

SSA, PCNL, ASA

INTRODUCTION

Fernstrom I and Johannson B reported the removal of renal calculus through nephrostomy tract by open surgery in 1976, though at present PCNL has become the treatment of choice for removal of renal stones [1]. Percutaneous Nephrolithotomy (PCNL) is the treatment modality used for the extraction of large renal stones or multiple calculi or stones resistant to shock wave lithotripsy. With the enhanced expertise of surgeons, skills of anaesthesiologist and advancement in instrumentation, PCNL is nowadays the procedure of choice [2].

PCNL is used for larger renal stones of size more than 20 mm, staghorn stones and stones that are multiple or resistant to extracorporeal shock [3]. PCNL can be done under local, general or regional anaesthesia. The General Anaesthesia (GA) is the standard modality for PCNL [4]. The literature mention that GA has many advantages over Regional Anaesthesia (RA) in term of better haemodynamic control, airway control, better patient and surgeon satisfaction [5]. A meta-analysis published in 2015 by Hu H et al., on RA versus GA for percutaneous nephrolithotomy found mean operative time was shorter, discharge of patients was earlier, and less pain on first postoperative day in RA group than GA group [6]. There was no significant difference in stone free status in RA versus GA. General anesthesia (GA) has a higher risk of complications even in the general population, and more so in those with co-morbidities [7]. The complication and contraindications of GA, such as pulmonary atelectasis, Chronic Obstructive Pulmonary Disease (COPD), vascular, and brachial nerve injury or spinal cord injury and also The total cost of GA is more as compared to SA [8]. Few studies conclude that Segmental Spinal Anaesthesia (SA) can be an alternative method of anaesthesia with similar incidence of complications [9]. SA has many advantages over GA, like better postoperative pain control in turn less consumption of analgesic drugs and avoidance of side effects of multiple medications used in GA. The rate of complications was also less in PCNL surgeries with use of SA [10].

Bupivacaine is long-acting local anesthetic with a low therapeutic index due to cardiovascular toxicity [11]. But its S(-) enantiomer, 'levobupivacaine' has less of negative inotropism and decreased affinity for cardiac sodium channels, offering an improved safety profile [12]. The spread of isobaric solution in cerebrospinal fluid does not depend upon the patient's position during and after the injection. Thus, intrathecal isobaric levobupivacaine does not spread unexpectedly high, and levels of sensory block after spinal isobaric levobupivacaine are unaffected by the change in patient position following the injection [13]. Hyperbaric solutions may cause sudden cardiac arrest after spinal anesthesia because of the extension of the sympathetic block [14,15]. Isobaric solutions are favoured due to their less sensitive to position issue properties. The purpose of the study was to provide comprehensive review of SSA in PCNL patients, focusing on its benefits, technique, clinical outcomes and challenges.

Methodology:

Ten cases of elective PCNL surgeries conducted under segmental spinal anesthesia at our tertiary care center from May 2023 to May 2024 chosen for conducting a case series on this specific topic. Anesthesia & surgery were performed by the same anesthesiologist and surgical team. After complete pre-anaesthetic evaluation, patients having renal calculi were selected randomly between the age group of 18-60 years with ASA grade I/II. There was no preference to gender, size, location and laterality of stone or BMI. All the patients fit into the American urological association guideline criteria for management by percutaneous nephrolithotomy. All patients received extensive and detailed explanation of the procedure including the possibility of intraoperative conversion to GA if needed. Written informed consent for publication of medical data was obtained from all patients. The demographic characteristics and baseline haemodynamic data were recorded. All patients were preloaded with 500ml Ringer' lactate .after local infiltration of 2% 2ml lignocaine at the site of spinal block, SSA was given in sitting position with 0.5 ml of 0.5% hyperbaric bupivacaine followed by 0.5% isobaric levobupivacaine 1.2 ml with 30mcg fentanyl as adjuvant (total volume of 2ml) in T10-T11 intervertebral space targeting the desired spinal segment, by 25 G pencil point spinal needle under all aseptic precautions. The Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), and Heart Rate (PR) were recorded at 5min, 10 min, 15 min, 30 min, 60 min, 90 min & 120 min.

Time of spinal block was taken as 0 min. surgery was started after achievement of bromage scale 3. The operative time was recorded from the beginning of anaesthetic administration to termination of the operation. the level of motor block was evaluated on a 4-point scale (Bromage Scale): 1=able to lift extended legs, 2=just able to flex knees, full ankle movement, 3=no knee movement, some ankle movement, 4=complete paralysis.[16] The onset of sensory block was assessed by the loss of discrimination to pinprick (five consecutive pricks with the tip of a 25G hypodermic needle within an area of three cm in

diameter)[17].

At the completion of surgical procedure, adverse effects including hypotension, bradycardia, nausea, vomiting, shivering or pruritus were recorded during postoperative period. Hypotension was defined when SBP was<90 mm Hg. Bradycardia was defined when pulse< 60 beat/min. Hypotension was managed with fluid bolus and Inj Mephentermine 3 mg. The number of patients who needed conversion from SA to GA was recorded. At the end of the operation, patients' satisfaction score was recorded from 0 (extremely unsatisfied) to 5 (extremely satisfied) [18]. The patients were advised to have complete bed rest for at least 24 hours postoperatively. The patients were discharged after 72 hours of PCNL.

RESULT

Ten patients having renal calculi were selected randomly between the age group of 18-60years. Three patients were known cases of hypertension, four patients had DM with ITN & three were without any co-morbidities. Mean patients age was 44.7±12.91 years, & 50% were male & 50% were females. About 80% of having ASA grade II. and 20% grade I (Table 1)

Table 2 shows the duration required for adequate anaesthesia in case series. During all anesthetic and surgical procedures no major complications and no need for conversion from SSA to GA were reported, and no patient required sedation. Intraoperative hypotension & bradycardia was documented exclusively in two cases (20%), treated with intravenous fluid &inj mephentermine 3 mg. Patients satisfaction score was noted at the end of the surgery and it was good for all the patients. Post-operative analgesia was measured upto the time of first rescue analgesia and it was varied from 3.5 to 5 hours after accomplishment of the surgery. (Table 3) Rescue analgesia was given on patient request. Table 4 shows mean values of haemodynamic variables at the different time interval.

Table 1: Baseline characteristics of the case series

Case	Age	Gender	ASA	Co-morbidity	Segment block level
1	60	M	II	HTN,DM	T4-L2
2	55	F	II	HTN	T4-L4
3	24	F	I	None	T6-L4
4	50	F	II	HTN,DM	T6-L4
5	50	M	II	HTN	T6-L5
6	54	M	II	HTN	T6-L5
7	35	M	II	HTN, DM	T4-L4
8	54	M	II	HTN,DM	T6-L4
9	25	F	I	None	T4-L4
10	40	F	II	None	T6-L5

Table 2 : Duration required for adequate anesthesia

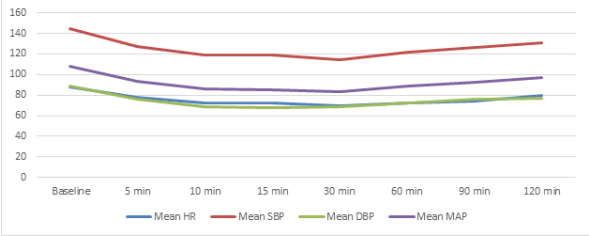
Case	Sensory block onset (Min)	Motor block onset (Min)	2 segment regression (Min)	Total regression(Min)	Duration of surgery (Min)
1	1.5	2.2	110	180	90
2	1.2	2.2	130	220	60
3	1.2	2.4	120	200	60
4	1	2.2	130	230	80
5	1.2	2	120	200	80
6	1.4	3	135	240	60
7	1	2.2	120	200	60
8	1.2	2.4	120	220	90
9	1.3	2.5	125	220	60
10	1.2	2.4	120	220	60

Table 3 : Intraoperative findings

Case	Complication	Conversion to GA	Sedation required	Patient satisfaction score	Rescue analgesic
1	None	No	No	Extremely satisfied	4hr
2	None	No	No	Extremely satisfied	4.5 hr
3	None	No	No	Extremely satisfied	4hr
4	None	No	No	Extremely satisfied	4hr
5	Bradycardia & Hypotension	No	No	Extremely satisfied	4hr
6	None	No	No	Extremely satisfied	5 hr
7	None	No	No	Extremely satisfied	4hr
8	None	No	No	Extremely satisfied	3.5hr
9	Bradycardia & Hypotension	No	No	Extremely satisfied	4.5 hr
10	None	No	No	Extremely satisfied	4 hr

Table 4 : Mean values of haemodynamic variables

Parameter	Mean HR/min	Mean SBP (mmhg)	Mean DBP (mmhg)	Mean MAP (mmhg)
Baseline	88.4±9.5	145±19.62	88.9±6.08	107.7±9.06
5 min	77.6±10.97	127.7±22.06	76.3±6.05	93.3±10.65
10 min	72.4±9.83	119.3±21.08	69±8.02	85.8±12.21
15 min	72.7±8.73	118.9±17.98	68.2±8.02	84.9±10.47
30 min	69.4±10.64	114.9±17.20	68.4±9.27	83.5±11.51
60 min	72.2±9.84	121.8±13.74	72.7±9.4	88.9±9.08
90 min	74.5±10.72	126.2±12.98	75.7±10.17	92.3±10.50
120 min	79.3±12.35	130.8±13.31	77.4±13.59	97±11.64



Graph 1: Mean values of haemodynamic variables

Table 5 : Operative Variables

Mean duration of sensory onset	1.22±0.15 min
Mean duration of motor Onset	2.35±0.27 min
Mean duration of two segment regression	123±7.15 min
Mean duration of total regression	213±17.66 min
Mean duration of Rescue analgesic	4.15±0.41 min
Mean Operative time	70±13.33 min

Mean operative time was 70±13.33 min, the mean duration of sensory block was 1.22±0.15 min, mean duration of motor block was 2.35±0.27 min, mean duration of two segment regression was 123±7.15 min, mean duration of total regression was 213±17.66 min. Mean duration of rescue analgesic was 4.15±0.41 min. (Table 5)

DISCUSSION :

The PCNL results in less morbidity and shorter convalescence. PCNL is used for the breakdown and removal of large or multiple calculi from the renal pelvis and renal calyceal system [2]. The literature shows that PCNL can be done under assisted local anaesthesia [19]. GA can be a challenge in PCNL for staghorn calculi, because of the possibility of fluid absorption and electrolyte imbalance. Therefore, RA would be a better alternative in these circumstances [20]. In this present study, we have used isobaric levobupivacaine for targeting desired spinal segments and hyperbaric bupivacaine for cystoscopy procedure.

The mean age of patients in our study was 44.7±12.91 years. The mean age of patients in study by Mehrabi S et al. was 40.0±14.3 years [21] whereas study conducted by Kamal M et al. was 38.0±17.1 years [21]. The mean operative time was 70±13.33 minutes which is lower as compared to study conducted by Kamal M et al. (95.0±37.8 minutes) & by Mehrabi S et al. (80.0±25.9 minutes) [20,21]. The mean total regression duration was 213±17.66 min. Return of sensory and motor activity in study conducted by Kamal M et al. was 140.0±19.7 minutes and 121.0±23.8 minutes respectively [21] ,may be due to difference of dosages in two studies

Mehrabi S et al., compared the efficacy and complications of SA versus GA in PCNL [20]. The incidence of hypotension, headache and low back pain in postoperative period were more in SA group than the GA group with a significant difference ($p<0.05$),which are naturally due to effects of spinal anaesthesia

Movasseghi G et al., compared the preference of SA or GA for PCNL [22]. The haemodynamic parameters (MAP and PR) showed no significant variability at same time points between two groups ($p>0.05$). The duration of surgery and anaesthesia, amount of bleeding, and requirement of analgesic were significantly less in SA group ($p<0.05$). In our study total surgical time was less in comparison to this study probably because of less stone burden and concludes that in patients undergoing PCNL, SA is as effective and safe. The similar conclusion was also made by Mehrabi S et al., who evaluated intraoperative and postoperative anaesthetic and surgical outcomes in 160 patients who underwent PCNL under SA in the prone position and concluded that the SA is safe as well as effective type of anaesthesia and is a good alternative of GA in adult patients for PCNL [20]. Kuzgunbay B et al., also concluded that PCNL can be done under SA to the satisfaction of the patient, surgeon and anaesthesiologist [23].

Advantages of SSA: as the block levels are specific and limited, No extra preloading with crystalloid is necessary No highly significant haemodynamic changes occur during change of position from supine to prone and vice versa Patient is conscious,breaths normally, there is no need to control the airway No significant hemodynamic changes There is early recovery of block as compared to conventional spinal anaesthesia with hyperbaric drug use Only in two patients in our study there was hypotension & bradycardia. As stated by Uppal et al., hyperbaric spinal drug has its complications mainly due to cephalic spread along the gravity like hypotension, bradycardia, high and total spinal etc. [24]. Use of isobaric drug with reduction of hyperbaric drug could potentially reduce the complications of former and could enhance the efficacy and safety of the overall procedure. Similar finding was noted by Rung et al.[25].

The study conducted by Imbelloni LE et al used thoracic spinal anesthesia with low dose isobaric & low dose hyperbaric bupivacaine for orthopedic surgery & found that beginning of the block is fast regardless of the solution used. By providing a sensory block of longer duration than the motor block hyperbaric bupivacaine is reflected in a better indication [26]. The study by Singhal G et al found that TSSA is a safe and effective option for PCNL, providing better hemodynamic stability with lesser incidence and reduced intra-operative hypotension compared to conventional Lumbar spinal anaesthesia [27]. Also study by van Zundert AAJ et al conclude that segmental spinal anaesthesia can be used successfully and effectively for laparoscopic surgery in healthy patients [28].

CONCLUSION:

On the basis of case series that we have conducted, we can conclude that segmental spinal anaesthesia with the combined sequential use of hyperbaric and isobaric local anaesthetic drugs can be used for PCNL surgeries with better efficacy, safety and reduced intra-operative complications. These in turn can enhance patient's recovery. But more studies on the topic with greater sample size and at multiple centres needs to be done in future for adding safety in the procedure.

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