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Efficacy and Safety of Percutaneous Nephrolithotomy under Spinal Anesthesia

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ABSTRACT
The patients harboring Staghorn calculi, large kidney calculi, multiple calculi, or calculi resistant to shock wave lithotripsy are generally treated using percutaneous Nephrolithotomy (PCNL), with the standard modality being general anesthesia. This study is aimed to assess the efficacy of PCNL under spinal anesthesia (SA). Data were collected from 418 patients who underwent PCNL under SA, including the surgery parameters, demographic data, postoperative findings, and urinary system and stone characteristics. Among the enrolled 418 patients, 184 patients were female and 234 were male, with a mean age of 44.35±14.05 years. Mean stone load was 34.44±15.10 mm, with an average duration of surgery of 65.70±18.98 min and the mean hospitalization period of 42.29±11.70 h. The overall success rate was 87.32%. During the first 10 min after induction, 42 (10.04% patients exhibited hypotension that was managed by intravenous administration of ephedrine. Twenty patients (4.78%) needed blood transfusion, and 22 patients (5.26%) complained of dizziness, lower back pain, and headache that were managed with bed rest and analgesics. Nineteen patients (4.54%) suffered from postoperative fever. There were no major complications. Under SA, adult patients can be safely treated with PCNL with low complication and high success rate.

Keywords: Spinal anesthesia; stone-free rate; percutaneous nephrolithotripsy

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INTRODUCTION

With a global incidence of 4%-20%, urinary stone disease is one of the commonest health problems [1]. Patients suffering from multiple calculi, Staghorn calculus, calculi resistant to extracorporeal shockwave lithotripsy or large pelvic and kidney stones are generally treated using percutaneous Nephrolithotomy (PCNL). PCNL is a common procedure in end urology that was first introduced by Fern Storm and Johansson in 1976 and then further developed in the following years [2]. It is difficult for patients suffering from Staghorn calculus to be anesthetized while undergoing PCNL due to potential complications including significant blood loss, hypothermia, dilutional anemia, or fluid absorption. In general, an efficient anesthetic agent is defined as one which, when administered, causes rapid onset and reversal of anesthesia, does not majorly disturb the hemodynamic of the patients during the surgery, and reduces the post-operative recovery time by lessening nausea, analgesic requirement, and post-operative pain [3]. Till 1988, all the procedures were performed under general anesthesia (GA) because it offered patient comfort and controlled ventilation. From 1988 onwards, various regional techniques adopted to reduce morbidity, bloodless, post-operative pain, hospital stay and cost. Some of these techniques include spinal anesthesia (SA), epidural anesthesia, combined spinal epidural, skin infiltration with renal capsule block, and inter pleural block. We chose SA for the study because of its maximum predictability and success rate among the regional techniques. PCNL procedures were often performed under SA in our center. In this study, we present the intraoperative and postoperative data of 418 patients undergoing PCNL who were anesthetized using SA and operated on by same surgeon. Here, we evaluated the intraoperative and postoperative outcomes.

METHODS AND MATERIALS

Between September, 2016 and August, 2019, 418 patients underwent PCNL under SA. For all these patients, we recorded the size of the calculus, surgery parameters (fluoroscopy time, duration of surgery, blood transfusion, tract location and number, and other complications), and postoperative outcomes (requirement of blood transfusion, duration of being hospitalized, stone-free rate, and complications). The patient consent was obtained for type of anesthesia. The urologic workup included ultrasonography of abdomen, intravenous xylography, and kidney ureteral and bladder (KUB) x-ray. If necessary, the patients were also advised to undergo computed tomography scan. The general physical examination, including Fasting Blood Sugar, Serum Creatinine, Blood Urea Nitrogen, Complete Blood Count, Prothrombin Time, and Partial Prothrombin Time, were done for all the patients. All patients were under prophylactic antibiotic cover of 500 mg Impenem immediately before surgery.

Spinal Anesthesia Technique

All the patients were sedated with an intravenous dose of 3-5 mg midazolam, after which they were instructed to sit on the operation table. Next, 0.5% Bupivacaine hydrochloride (15-20 mg) was injected through L3-L4 intervertebral space into the subarachnoid space via a 25 Gauge spinal needle under aseptic condition. Standard intra-operative monitoring included pulse oximetry, electrocardiography, and non-invasive blood pressure. Patients were placed in supine position for 10 min and checked for sensory level of T6 dermatome with pin prick.

PCNL

Following the administration of SA, an open-ended 6Fr catheter and a cystoscopewere inserted into ipsilateral ureteral in lithotomic position and then fixed to a 16 Fr urethral catheter. All patients received oxygen by bi-nasal

prongs, and verbal contact was maintained with them throughout the procedure. A radio-opaque agent was used to visualize the pelvicalyceal system (PCS) of the patient in the prone position, which was then punctured using an 18 Gauge TLA needle. Next, a 0.038 inch guide wire was inserted into the collecting system, and the tract was dilatated using the Amplatz renal dilator. An ultrasonic lithotripter was used to break the stone(s), which were then extracted out using graspers. Fluoroscopy or nephroscope was employed to verify that the patient was stone-free. For individuals harboring multiple calculi in more than one calyx, another access was created if the previous access did not result in maximal stone-free status. After protocol completion, a 24 Fr nephrectomy tube was inserted through the renal sheath. The stone pieces with less than or equal to 4 mm diameter were defined as clinically insignificant residual fragments. The patients were discharged after 36-48 h of surgery. A follow-up was done for all patients at 2 weeks after surgery with either urinary ultrasound or KUB x-ray.

Results

The recruited patients included234male males and 184females. The mean stone load, age, duration of surgery, and hospitalization time were 34.44±15.10 mm, 44.35 ± 14.05 years, 65.70 ± 18.98 min, and 42.29 ± 11.70 h, respectively. Overall, the stone-free rate was 87.32 %. Table 1 shows the surgery parameters as well as the demographic characteristics of the patients. Three hundred sixty-five patients were subjected to a sub costal access, while 53 patients were subjected to an intercostals access. We did not observe any signs of pneumothorax or hydrothorax in the patients that had intercostals access. After the surgery, 19 patients (4.54%) suffered from a fever but were cured with an adequate regimen of antipyretics and antibiotics. Twenty (4.78%) patients exhibited hemorrhage and required blood transfusion. We did not observe urosepsis or intra-abdominal organ injury in any patient, and none of the patients needed an open surgery. In addition, we did not observe any neurologic or infectious complications. Ninety (21.53%) patients suffered from bradycardia that was treated with I.V. dose of atropine. Forty-two (10.04%) patients exhibited hypotension at 3-10 min after the administration of regional anesthesia, which was countered by an I.V. dose of ephedrine. During 24 h postoperatively, overall average hemoglobin decrease was 1.67 ± 0.47 g/dL. Twenty patients (4.78%) required packed cell transfusion. Postoperatively, 48 (11.48%) patients exhibited nausea/vomiting and 22 (5.26%) patients suffered from mild lower back pain and moderate post-subarachnoid puncture headache. However, their condition improved with non-steroidal anti-inflammatory drugs, conventional analgesics, and bed rest. Thirty-one (7.41%) patients exhibited shivering after the surgery. Eleven (2.63%) patients who complained of discomfort in the prone position were administered 0.5 mg midazolam, table (2).

Table (1): Surgery parameters and patients' demographic characteristics

Parameter	N =418
Sex(M/F)	234 / 184
Mean Age (years)	44.35 ± 14.05
Mean Stone Burden (mm)	34.44 ± 15.10
Mean Surgery Duration (min)	65.70 ± 18.98
Mean Fluoroscopy Time (min)	2.60 ± 0.95
Mean Hospitalization Duration (hours)	42.29 ± 11.70
Intercostals Access (n, %)	53 (12.67%)
Sub costal Access (n, %)	365 (87.32%)
Single Access (n, %)	379(90.66%)
Double Access (n, %)	39 (9.33%)
Stone-Free (n, %)	365 (87.32%)

Table (2): Complications of PCNL with SA

No. of patients	Complication	Sl. No.
90 (21.53%)	Bradycardia	1
42 (10.04%)	Hypotension	2
21 (5.02%)	Severe Peri-operative pain	3
20 (4.78%)	Blood loss requiring transfusion	5
48(11.48%)	Nausea/Vomiting	6
22 (5.26%)	Headache	7
31 (7.41%)	Post-operative shivering	8

DISCUSSION

Administration of anesthesia is a crucial part of surgery. The preferences of surgeon and patient, feasibility, anesthesiologist's skills, Perioperative costs, and intra- and post-operative costs determine the preferred anesthetic technique to be employed [4]. Owing to more patient comfort and better regulation of breathing, GA is the preferred anesthetic technique during PCNL. However, GA is occasionally accompanied with certain side-effects, such as drug allergy, postoperative vomiting/nausea, and pulmonary complications [5]. Other related concerns might include neurologic events and tracheal tube displacement while shifting the patients to prone position [6]. PCNL under regional anesthesia was first reported in 1988, where 112 patients were operated [7]. They were given epidural anesthesia with

88% hemodynamic and respiratory parameter satisfaction. The largest prospective study under SA involved 387 patients spread over 9 years by Babak Borzouei et al. [8]. The study showed that SA is a well-tolerated, safe, and feasible method, particularly for elderly patients with cardiac and pulmonary co morbidities. The purpose of doing PCNL under SA is to reduce the complications of GA. This becomes more significant in elderly patients and in those with significant co morbidities. However, in the case of SA, if a suitable level cannot be achieved, then the procedures have to be abandoned or converted to GA with possible complications. Since the patients under SA can still follow verbal commands and manage their breathing well, this technique helps in better prevention of neurologic events and pulmonary complications during supracostal puncture and patient positioning. The above findings have previously prompted the need of assessing the effects of other regional and local anesthetic techniques, such as renal capsular block, interpleural block, SA, epidural anesthesia, combined spinal epidural anesthesia, and peritubual infiltration [9-12]. In the studies on PCNL under SA, the hospitalization time varied. Singh et al. observed reduced hospitalization time for patients under regional anesthesia [13]. For patients undergoing PCNL under SA, previous studies have reported reduced postoperative pain, more rapid postoperative healing, and reduced loss of blood [14]. Another study reported better peri- and post-operative hemodynamic and respiratory profiles and less complication rates in patients under SA [15]. Under other anesthetic techniques, previous studies have reported 53.8 to 98.0% stone-free rate, while some studies have reported no effect on the outcome of PCNL under SA [16-17].We observed a stone free rate of 87.32%. Success depends on many variable factors like experience and skill of the surgeons, hardness, position, number, size of the stones, bleeding reducing visibility, dilatation of renal system, availability of laser, etc. Sofikerim et al. [18] reported the experience of the surgeon as the most important factor that affects a surgery's outcomes. Another factor that affects the PCNL outcome is the stone burden. Clayman et al. reported 89% success rate for calculi larger than 2 $cm^2$and 97%-100% success rate for those smaller than 2 cm^2 [19]. Another study reported 88%-91% success rate for stones smaller than 3 cm^2 and 75% for stones larger than 3 cm^2 [20]. Even with easy and better access to PCS using intercostals access, sub costal access provides lesser complications, such as pneumothorax, hydrothorax, etc. However, in the patients subjected to intercostals access in our study, we did not observe any of these complications. In a previous study on PCNL under SA, Mehrabi et al. [16] reported that 3.8% of the recruited patients complained of headache. A few studies reported that 6.3 to 10.9% of the patients, who underwent PCNL under SA, required blood transfusion. In this study, we observed that 5.26% patients complained of headache, 4.54% patients suffered from fever, and 4.78% patients exhibited hemorrhage and required transfusion. However, we did not observe urosepsis, injury to any adjacent organ, or severe hemorrhage that required open surgery or mobilization. The rate of complications was also less in PCNL surgeries with use of SA [10]. In a previous study conducted by Mehrabi et al., the mean age of patients, the mean calculus size, and the average surgery duration were 40.0 ± 14.3 years, 34.2 ± 9.8 mm, and 95.0 ± 37.8 min, respectively [21], which were different from our outcomes (44.35 ± 14.05 years, 34.44 ± 15.10 mm, and 65.70 ± 18.98 min, respectively). Stoller ML et al. showed that 14% of the patients who underwent simple single puncture PCNL required blood transfusion, and the mean decrease in hemoglobin was 2.8 g/dL [22]. In our study, the incidence of blood transfusion was 4.78% and mean decrease in hemoglobin was 1.67±0.47 g/dL. Overall, these data confirmed that, with respect to intraoperative bleeding, SA is feasible and safe during PCNL. In our study, total surgical time was less because of less stone burden. The anesthetic procedure, characteristics of the patient, and experience of the surgeon determined the overall surgery duration of the patients undergoing PCNL. Previously, Borzouei B and Mousavi-Bahar SH assessed the efficacy and safety of SA during PCNL in 387 patients harboring renal calculi. They achieved a 94.1% success rate with 11.6% patients suffering from complications. They concluded that, for renal calculi patients undergoing PCNL, SA was a well-tolerated, safe, and feasible technique. The results of several previous studies showed a reduced intra-operative bleeding in patients under SA compared to those under GA [23-25]. Although the previously reported rate of transfusion during PCNL is about 5% to 12%, only 4.78% of patients in our study needed blood transfusion. The intra-operative shivering can be multi factorial and was observed in 31 (7.41%) patients recruited in our study. Large amounts of irrigation fluids can induce hypothermia and, hence, shivering. Another factor is the bacteremia produced by the manipulation of stones and the urinary system. In our study, 15.55% of the patients had previously undergone renal surgery; however, it had no effect on stone-free rates. SA has many advantages over GA, including better postoperative pain management, lesser requirement of analgesic drugs, and reduced number of side effects. SA has also been reported to mediate lesser postoperative pain and favorable operative factors by Mehrabi et al [16-21].

RESULTS AND CONCLUSION

Among the enrolled 418 patients, 184 patients were female and 234 were male, with a mean age of 44.35±14.05 years. Mean stone load was 34.44±15.10 mm, with an average duration of surgery of 65.70±18.98 min and the mean hospitalization period of 42.29±11.70 h. The overall success rate was 87.32%. During the first 10 min after induction, 42 (10.04% patients exhibited hypotension that was managed by intravenous administration of ephedrine. Twenty patients (4.78%) needed blood transfusion, and 22 patients (5.26%) complained of dizziness, lower back pain, and headache that were managed with bed rest and analgesics. Nineteen patients (4.54%) suffered from postoperative fever. There were no major complications. Under SA, adult patients can be safely treated with PCNL with low complication and high success rate.

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