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Spinal Versus Epidural Anesthesia for Patients with Chronic Obstructive Pulmonary Disease Undergoing Supine Percutaneous Nephrolithotomy for Management of Renal Stones. A Prospective Double-Blind Randomized Clinical Trial

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ABSTRACT

Background: Regional anesthesia is currently a panacea for preventing or minimizing complications in chronic obstructive pulmonary disease (COPD) patients. **Objective:** This unique study compared the efficacy and safety of segmental thoracic spinal anesthesia (TSA) versus segmental thoracic epidural anesthesia (TEA) in COPD patients undergoing percutaneous nephrolithotomy (PCNL) for renal stones removal in the supine position.

Patients and methods: One hundred COPD patients, both sexes, ages 40 to 80, with ASA physical status classes II and III, were prepped for elective PCNL for renal stone. The patients were split into two groups of fifty. One group (TSA) was given segmental thoracic spinal anesthesia while the other group (TEA) was given segmental thoracic epidural anesthesia. Our primary and secondary outcomes were changes in pulmonary PO_2 and PCO_2, incidence of various side effects, postoperative pain severity, characteristics of utilized neuroaxial blockade, and changes in hemodynamics.

Results: When comparing the two groups, we found no statistical significance in terms of demographics, hemodynamics, pulmonary function gains, adverse events, surgeon and patient satisfaction, or postoperative visual analog scale. The onset of the block was quicker and less amount of local anesthetic was needed in the TSA compared to the TEA. Conversely, the incidence of hypotension was higher in the TEA group than in the TSA group.

Conclusion: Our study demonstrated that TSA is easier, safer, and has a faster onset of action, provides a more predictable block, has less hemodynamic instability, and has fewer technical failures compared to TEA.

Keywords: COPD, PCNL, Thoracic spinal anesthesia, Thoracic epidural anesthesia.

INTRODUCTION

Owing to the elevated risk of perioperative comorbidities, chronic obstructive and restrictive pulmonary disorders can be a challenging task for the anesthetist. Endotracheal intubation and intermittent positive pressure ventilation (IPPV), two hallmarks of general anesthesia (GA), are known to increase the risk of serious complications such as barotrauma, laryngospasm, and bronchospasm [1,2]. Patients who had neuroaxial anesthesia had lower rates of pulmonary, and cardiac problems and deep venous thrombosis after surgery compared to those who received GA [3].

The inflammatory pathogenesis of COPD not only impacts the lungs but also gives rise to extrapulmonary manifestations. These manifestations can be associated with various health issues such as weight loss, skeletal muscle dysfunction, cardiovascular disease, depression, and osteoporosis [2].

Patients with COPD have a wide range of options for anesthesia, depending on illness stage, type of surgery, and length of operation. General anesthesia (GA) is known to increase the risk of problems for patients with COPD, especially when paired with endotracheal tube insertion and mechanical ventilation. Increased risk of hypoxemia and intra- and postoperative pulmonary complications; laryngospasm; bronchospasm; lung barotrauma; hemodynamic instability; hypercarbia; prolonged postoperative mechanical ventilation; and difficulty in weaning are examples of such problems. This approach aims to minimize the risks associated with general anesthesia and its potential complications, providing a safer alternative for COPD patients undergoing different types of surgical procedures. Regional blocking, as opposed to GA, has been found to improve pulmonary outcomes in patients with severe COPD [3], and in patients with normal lung function [4].

Recent study has revealed that there is a wider gap between the dura matter and spinal cord in the mid-thoracic region, especially at the T7-T8 level. These anatomical characteristic makes the insertion of a spinal needle into the subarachnoid space relatively safer at this level [5]. However, it is important to note that despite this finding, strict precautions and adherence to established safety protocols are still necessary during the procedure. The potential risks associated with spinal anesthesia should not be overlooked, and healthcare professionals must ensure that the proper techniques and precautions are followed to minimize any potential complications [3,4].

AIM OF THE STUDY

This is a **unique study**, which was performed to identify and evaluate the outcomes of patients with COPD who underwent percutaneous nephrolithotomy (PCNL) for kidney stones.

The study aimed to compare the use of two different anesthesia techniques, namely thoracic spinal anesthesia (TSA) and thoracic epidural anesthesia (TEA), as a single anesthetic approach for the procedure. The goal was to assess the efficacy and safety of both techniques in this specific patient

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population (COPD) and to determine any differences in outcomes between the two anesthesia methods.

PATIENTS AND METHODS

This prospective randomized study spanned two years, starting from August 2022, at Sohag University Hospital. A total of 100 individuals with COPD were enrolled in the trial, including both men and women. The ages ranged from 40 to 80 years. Patient physical status was determined by either ASA II or III by the American Society of Anesthesiologists (ASA). Percutaneous nephrolithotomy (PCNL) operations in a supine position were performed on all individuals voluntarily.

Ethical approval:

Sohag University, Medical Research Ethics Committee approved the trial with IRB: 00013006 clinical trials approved it with approval number: NCT06663488. Written informed consents were obtained from all patients before the study began. The Helsinki Declaration was followed throughout the course of the investigation.

The following were exclusion criteria: a history of neuromuscular, hepatic, or renal problems; systemic conditions that could cause hypotension during the regional anesthesia procedure, such as severe aortic or mitral stenosis; allergy to local anesthetic; and injection site infection.

Patients with stage I-III COPD, defined as mild to severe airflow limitation and a forced expiratory volume in 1 second (FEV1/forced vital capacity (FVC) ratio below 70% of the normal value), were eligible for inclusion in this study. Patients were picked at random and then divided into two groups of fifty.

The first group, referred to as the **TSA group**, received thoracic spinal anesthesia, while the second group, known as the **TEA group**, received thoracic epidural anesthesia. Certain exclusion criteria were applied to the study. Patients who declined neuroaxial anesthesia in favor of general anesthesia, those with local infections at injection site, deformities of the lumber or thoracic spine, coagulopathy or platelet dysfunction, diabetic patients with peripheral or central neurological dysfunction, pulmonary artery systolic pressure exceeding 50 mmHg, obesity (BMI $\geq$ 40), ASA physical status classification more than III, partial arterial pressure of carbon dioxide ($PaCO_2$) exceeding 60 mmHg, partial arterial pressure of oxygen (PaO_2) below 60 mmHg on room air, and patients with allergies to local anesthetic drug (bupivacaine) were excluded from the study.

The initial management approach for all patients with COPD involved several interventions aimed at improving pulmonary function. These included cessation of smoking for a minimum of eight weeks, chest physiotherapy, and administration of bronchodilators, steroids, and antibiotics for the treatment of any existing chest infection. Before the surgical procedure, a comprehensive preoperative assessment of the patient's overall health was conducted, which involved taking a detailed medical history, performing a clinical examination, and reviewing all relevant investigations. Additionally, the patients were briefed on the use of the visual analog scale (VAS) to assess pain severity upon arrival in the operating room.

Prior to the procedure, a wide-bore peripheral intravenous line was established, and a central line was inserted to monitor central venous pressure, followed by the administration of 500 ml of Ringer's solution.
All patients were premedicated with ranitidine 20 mg one hour before the procedure. Every patient was under prophylactic antibiotics after doing sensitivity test. An arterial line was placed into the radial artery of the non-dependent arm to permit arterial blood gas (ABG) sampling. Throughout the process, the patient's ECG, oximetry, noninvasive blood pressure, respiratory rate (RR), invasive blood pressure, central venous pressure, and urine flow rate were continuously monitored.

Surgical technique (Percutaneous Nephrolithotomy Technique):

Every patient received PCNL while in a supine position. Following a lithotomy position cystoscopic ureteric catheterization, the patient was moved to a supine position. The appropriately sized Amplatz sheath was deployed after the tract was dilated using serial dilators up to 24 Fr–28 Fr and punctured using the Bulls eye technique under fluoroscopic guidance. Pneumatic lithotripters or Ho: YAG lasers were used to break up the stones, and a grasper was used to remove the fragments after a nephroscope was added to the collection system.
After the procedure, a Double J (DJ) stent was placed in each patient, and the surgeon could choose whether or not to insert a nephrostomy tube.

Regional block technique

The block was performed either in the sitting position or in a lateral position. Local anesthetic infiltration was carried out using 2 ml of lidocaine (2%) through the predetermined interspinous space under strict sterile precautions.

Group TSA: Segmental thoracic spinal anesthesia was administered to all patients. The puncture site was cleansed with an antiseptic solution and the skin was infiltrated with 2 ml of lidocaine (2%). The patients were put either in a lateral decubitus or sitting position, and a paramedian approach was utilized for the puncture. The puncture site was typically located at the intersection of T7-T8. A 27G spinal needle was used, and after observation of free and clear cerebrospinal fluid (CSF), a mixture of 3.5ml of isosorbide bupivacaine (0.5%) and 0.5 ml of 200 µg morphine was administered intrathecally. Subsequently, the patients were positioned in a supine position to facilitate the spread of anesthesia.

Group TEA:
The epidural needle (Tuohy) was placed between the intersection of T7-T8. After verification of the correct epidural space using the loss of air resistance technique, and a test dose of 3 ml lidocaine (2%) with 5 µg /mL epinephrine, an epidural catheter was threaded 3 cm cephalad into the epidural space. Epidural anesthesia should produce sensory anesthesia between the T6 and T12 segments. Once the epidural catheter location had been verified, a total volume of 12 ml of plain bupivacaine (0.5%) plus morphine (0.1 mg/kg) was injected. Sensory testing was conducted every 2 minutes to ensure the sensory level at the T6 level. If indicated, a bolus of plain bupivacaine (top-up bolus 1-1.5 ml/segment) was injected to reach the desired sensory level (T6 level). The sensory level at the T6 level was examined at 15-minute intervals using a cold swab, and then a top-up bolus of plain bupivacaine was administered to reach the desired level (T6).
In both groups, ureteric catheterization could be done with the use of lidocaine gel injected inside the urethra.

All patients received oxygen through Venturi 60% during the procedure. Intravenous atropine was administered at a dose of 0.015 µg/kg in cases with bradycardia (heart rate <60 beats /min). Intravenous ephedrine was given in 5 mg doses to treat hypotension (arterial blood pressure below 20% of the preoperative value). Metoclopramide 10 mg was administered intravenously to treat vomiting.

After the surgical procedure, all patients were transferred to the surgical post-anesthesia care unit (PACU) for monitoring, clinical evaluation, and management of any complications or issues that might arise. Intraoperative irritability was managed through reassurance and the administration of a 1-2 mg intravenous bolus of midazolam.
To alleviate postoperative pain, rescue analgesia in the form of an intravenous infusion of 1 gm of paracetamol for mild pain (VAS 4-6) or intravenous meperidine was initially administered in an intravenous bolus of 1 mg/kg (for VAS ≥7).
In cases where the measures above failed to relieve pain, if the surgeon encountered technical difficulties during the surgery or if the patient expressed dissatisfaction with regional anesthesia at any time during the procedure, GA was administered.

Data recorded:
The following data and assessments were recorded for the patients:

1. Age, weight, gender, ASA physical status classes, length of surgery, and volume of blood loss.
2. The technical difficulty of inserting the needle and threading the catheter ranged from very easy to easy to difficult to extremely difficult.
3. Pain after surgery was monitored on a visual analog scale (VAS) at 2 h, 4 h, 8 h, 12 h and 24 h postoperatively (0 = no pain and 10 = worst pain possible).
4. Motor blockade was evaluated using the Modified Bromage Scale pre- and postoperatively and block regression was timed in minutes. A score of 0 indicated full hip flexion and a score of 3 indicated complete immobility of foot and leg in the extended position.
5. Heart rate (HR), and mean arterial pressure (MAP) were measured before surgery to establish a baseline, during surgery at a regular interval of 5 minutes, and immediately after surgery then at 2h, 4h, 8h, 12h, and 24h to assess any hemodynamic changes.
6. Variations in breathing were monitored by taking readings of arterial partial pressure of carbon dioxide ($PaCO_2$), and arterial partial pressure of oxygen (PaO_2) before surgery, at predetermined intervals throughout surgery, and one hour after surgery.
7. Surgeon and patient satisfaction scores were recorded on a four-point scale. I= poor II=satisfactory III=good IV= excellent. The patients were followed up for any other complications till discharge.
8. Adverse effects include headache, shivering, back pain, bradycardia, nausea, vomiting, bleeding, and temperature changes.

Sample size calculation
In a preliminary trial, 25 patients were randomly assigned to receive either an epidural or spinal block. Results from the two groups showed a mean difference of 0.55. The study's power was 100%, so there was a good chance of finding a real difference if one does exist. The risk of a type I error was managed by setting the permissible error at 5%. Using the statistical program OpenEpi, a sample size of 50 patients was determined for each group.

Statistical analysis
IBM SPSS version 22 for Microsoft Windows was used for all statistical analysis. Mean and standard deviation (SD) were used to describe continuous variables, median and IQR were used to describe non-normally distributed data, and frequency (number of cases) and percentages were used to describe categorical variables. Independent samples Student t-tests were employed to compare numerical normally-distributed variables between research groups. Categorical data were compared using the Chi-square test and Fisher's exact test was used when the anticipated frequency was less than 5. When the P value was less than 0.5%, statistical significance was assumed.

RESULTS

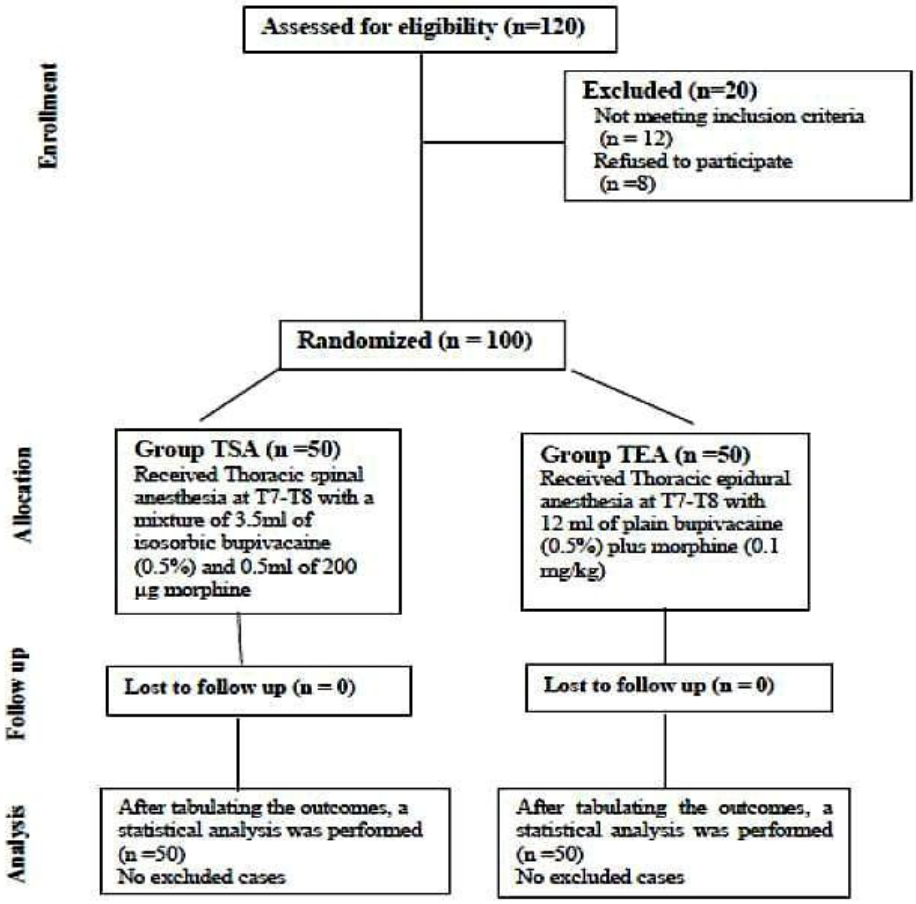

Figure (1): Consort flowchart.

Age, sex, weight, respiratory disease type (obstructive and restrictive), ASA category, surgery duration, interoperative blood loss, the need for blood transfusion, and mean hospital duration were similar between the two groups (Table 1).

Table (1): Demographic data.

	Group TSA (n=50)	Group TEA (n=50)	P value
Age (years)	56.3±11.7	57.3±13.7	0.65
Weight (kg)	88.4±8.6	94.3±6.7	0.30
Sex (male/female)	41±9	43±7	0.16
ASA II/III	25±25	22±28	0.56
Duration of surgery (min)	80.2±17.5	76.3±22.5	0.45
Blood loss (ml)	315.4±7.6	318.6±6.5	0.85
Blood transfusion (n, %)	3 (6%)	2 (4%)	0.67
Hospital duration (days) (median, IQR)	3(2-4)	3(2-5)	0.82
Nephrostomy tube duration (days)	2	2.1	0.23

The data are expressed as mean ± SD, number (%), or median (IQR).

The time required to progress to the T6 block level was drastically reduced in group TSA when compared to the TEA group. There was also a statistically significant difference between the groups in terms of the time it took to administer the initial rescue analgesia, which is an indicator of how long the pain was well managed. Time to initial rescue analgesia was shorter in the TSA group compared to the TEA group. There was no statistically significant difference between the groups on the pain rating scale created using the visual analog scale (VAS). This data demonstrates that, from the patient's perspective, the pain alleviation afforded by thoracic spinal anesthesia and thoracic epidural anesthesia was equivalent in the 1st 12 postoperative hours. At 24 h postoperatively, the pain was less in the TEA than in the TSA (Table 2).

Table (2): VAS, and rescue analgesia.

	Group TSA	Group TEA	P value
Time to first rescue analgesia (min)	410±51.43	625±72.23	<0.001
VAS 2h	2.2±1.1	1.9±0.9	0.78
VAS 4h	2.4±1.3	2.6±1.1	0.33
VAS 8h	2.9±1.1	3.1±1.2	0.76
VAS 12 h	3.3±0.8	3.2±0.9	0.35
VAS 24h	4.9±0.9	3.2±1.1	0.001
Time to initial rescue analgesia (h)	14±23	18±45	0.001
Patients requested additional analgesia: n (%)	3(6%)	2(4%)	1.00
Total paracetamol dose (mg)	400	300	0.35
Total meperidine dose (mg)	0	0	NS

Data is expressed as mean± SD.

There was no statistically significant difference between the TSA and TEA groups in terms of how simple it was to perform the block and technical ease. This means that both TSA and TEA were equally simple from a technical standpoint (Table 3). There was no significant difference between the studied groups regarding stone size, puncture site, retained or stone free patients (Table 3).

Table (3): Technical ease, access tract and success rate.

	Group TSA	Group TEA	P value
Ease of technique:			
• Very easy	35	30	0.2
• Easy	15	13	
• Difficult	0	7	
• Very difficult	0	0	
Stone size	2.23±1.12	2.41±1.18	0.21
Puncture site			
• Superior calyx	3(6%)	5 (10%)	0.56
• Middle calyx	13 (26%)	9 (18%)	
• Inferior calyx	34 (68%)	36(72%)	
Stone free patients	47 (94%)	46(92%)	0.55
Retained stone patients	3 (6%)	4 (8%)	

Data are shown as mean± SD or number (%).

There was a substantial gap in the two groups' times to reach the T6 block level. Group TSA also had a shorter mean regression period on the Bromage scale compared to the TEA group. Neither group differed on the Bromage scale for a motor block before surgery, however (Table 4).

Table (4): Sensory and Motor block criteria.

	Group TSA	Group TEA	P value
Time to obtain T6 level sensory block (min)	3.5±1.4	9.4±3.3	0.001
Motor block before start of surgery (Bromage scale)	0(0-1)	0(0-1)	NS
Motor block at the end of surgery (Bromage scale)	1(1-1)	1(1-1)	NS
Time for motor block regression to Bromage 0 (min)	250±35	340±23	0.007

Data is expressed as median (IQR) and mean ±SD. NS denotes non-significant.

Comparable findings found between the two groups were found for heart rate (HR) at preoperative (baseline), multiple interoperative, and 2 hours postoperative. However, statistical analysis showed that the MAP levels at various intraoperative measurement times were significantly lower in the TSA group compared with the TEA group in the 1st 25 minutes, and after that comparable readings were found (Figures 2, 3).

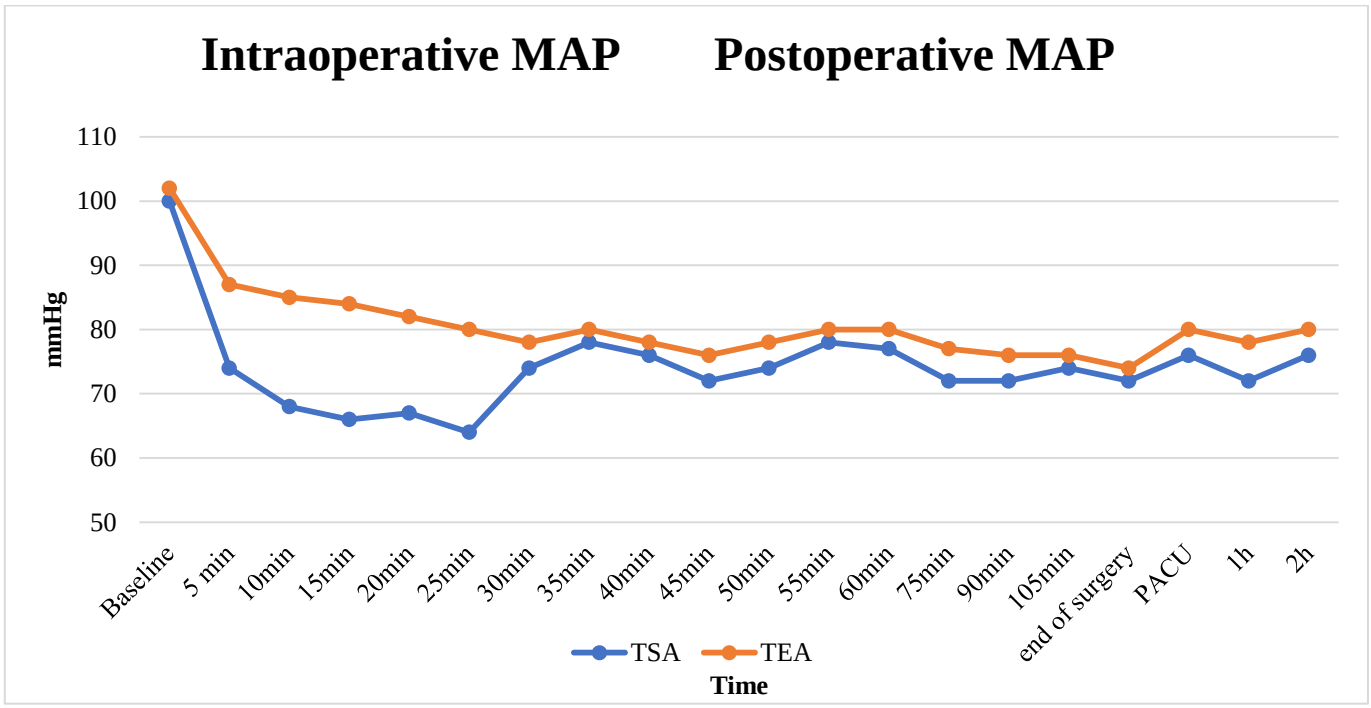

Figure (2): Intraoperative and postoperative mean arterial blood pressure.

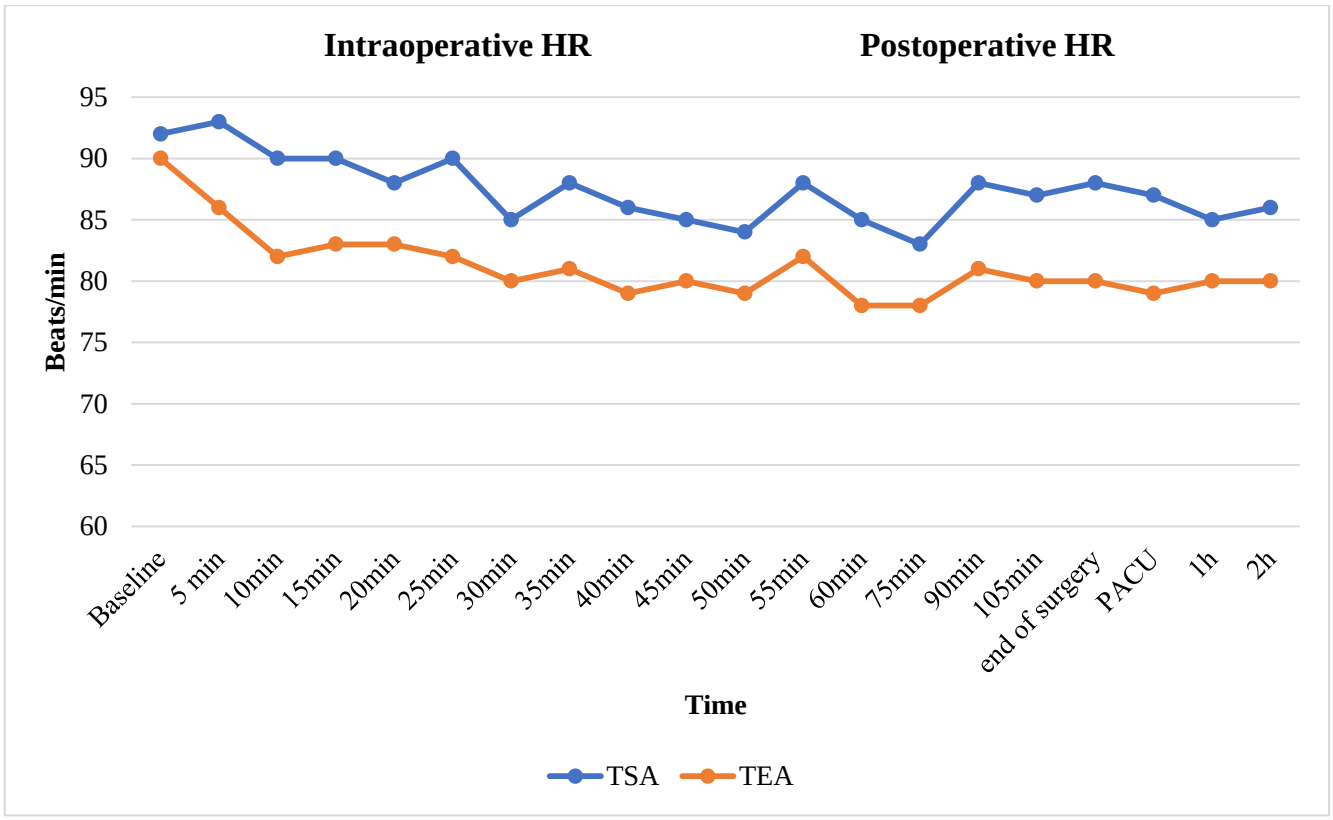

Figure (3): Intraoperative and postoperative heart rate.

The levels of arterial blood gases, especially $PaCO_2$ and PaO_2, were comparable between the two groups (TSA and TEA) preoperatively (baseline values), at different intraoperative measurement times and 1 and 2 hours postoperatively. There were no statistically significant differences in the PaO_2 and $PaCO_2$ values between the groups at various measurement times during the surgery and at 1 and 2 hours postoperatively. Therefore, the oxygen and carbon dioxide levels in the arterial blood remained stable and didn't show significant differences between the two and the anesthesia technique used in the study (Table 5).

Table (5): Preoperative, intraoperative, and postoperative arterial $PaCO_2$ and PaO_2 tension in both groups

	TSA	TEA	P value
$PaCO_2$ baseline	52.3± 4.3	54.3± 4.6	0.23
$PaCO_2$ 30 min	51.4±3.4	52.6±5.5	0.74
$PaCO_2$ 1 h	52.4±6.4	53.4±6.2	0.79
$PaCO_2$ at the end of surgery	53.4±4.3	51.3±5.4	0.11
$PaCO_2$ 1 h postoperatively	54.5±4.3	53.5±4.7	0.54
$PaCO_2$ 2 h postoperatively	51.5±4.3	52.5±4.7	0.54
PaO_2 baseline	87.5±3.6	86.6±4.2	0.44
PaO_2 30 min	85.6±3.4	86.4±3.2	0.34
PaO_2 1 h	86.4±3.2	85.4±3.4	0.23
PaO_2 at the end of surgery	84.6±4.6	85.6±3.7	0.72
PaO_2 1 h postoperatively	83.5±4.6	84.6±5.4	0.76
PaO_2 2 h postoperatively	85.5±4.6	86.6±5.4	0.45

Data are presented as mean± SD

There were no significant differences between the two groups (TSA and TEA) in terms of the need for interoperative non-invasive ventilatory assistance and sedation. The incidence of side effects was comparable in the two groups. However, the occurrence of hypotension, tachycardia were significantly higher in the TEA group compared to the TSA group, while shivering was significantly higher in the TSA group compared to the TEA group (Table 6).

Table (6): Side effects

	Group TSA	Group TEA	P value
Patients required noninvasive ventilation	1(2%)	2(4%)	0.74
Patients required sedation	2(4%)	3(6%)	0.32
Hypotension	7(14%)	11(22%)	0.03
Tachycardia	6(12%)	13(26%)	0.01
Pruritus	4(8%)	3(6%)	0.34
Vomiting	9 (18%)	7 (14%)	0.65
Respiratory depression	1(2%)	2 (4%)	0.23
Intraoperative anxiety	5 (10 %)	7 (14%)	0.46
Shivering	11 (22%)	8 (16%)	0.025
Postoperative fever	2 (4%)	1(2%)	0.68
Prolonged drainage	1 (2%)	1(2%)	0.33

Data are presented as number (%).

Statistically, patient and surgeon satisfaction were comparable in both groups. There was no statistically significant difference between the two groups (Table 7).

Table (7): Patient, surgeon satisfaction.

	Group TSA	Group TEA	P value
Patient satisfaction I/II/III/IV	0/2/14/34	0/5/10/35	0.54
Surgeon satisfaction I/II/III/IV	0/6/8/36	0/10/10/30	0.33

Data are presented as the number of patients.

DISCUSSION

The first-line therapy option for renal stone disease is now PCNL. Most PCNL is carried out under GA. GA poses a significant risk of problems for patients with serious medical conditions, especially those with respiratory disorders (COPD). Anesthetic drugs, lithotomy, prone posture, intraoperative loss of consciousness, endotracheal intubation, extubation, postoperative restlessness, agitation, respiratory depression, and bronchial reactions including bronchospasm and accumulation of alveolar secretions are among the intraoperative dangers associated with GA. Postoperative pneumonia, unscheduled endotracheal intubation, chronic ventilation support, pneumothorax, prolonged intensive care unit (ICU) stays, postoperative pain and the use of analgesic in the form of nonsteroidal anti-inflammatory drugs (NSAID) or opioids with their respiratory depressant effect are all examples of postoperative problems [6].

Alternatives to GA for PCNL in patients with contraindications to GA or those with a high risk of complications include segmental thoracic epidural anesthesia and segmental spinal anesthesia. These methods of regional anesthesia have been proven to be safe and beneficial in several ways. They include vasodilation, resulting in decreased preload and afterload, which is beneficial for patients with cor pulmonale[2]. They also counteract the phrenic nerve

reflex inhibition caused by surgery and improve chest wall compliance by reducing muscle tone. There are two primary reasons why the T7-8 intervertebral space was selected for the block. To begin with, a segmental spinal block is achieved, maximizing the effect of local anesthetic and opioids in the optimal surgical segments (T6-T12). Also, the danger of injury to the spinal cord is lower at the T7 level because the dura matter is further away from the cord. It has also been discovered that the distance between the dura mater and the spinal cord is greater when the patient is seated with their head lowered, as opposed to lying supine or on their side[6].

The purpose of this research was to evaluate the safety and efficacy of segmental thoracic spinal anesthesia versus segmental thoracic epidural anesthesia as a substitute for general anesthesia during PCNL procedures in high-risk COPD patients.

In the present study, the intraoperative MAP was statistically lower in the TSA group in the first 25 min after the block compared to the TEA group. This is because the reduction in mean arterial pressure began earlier and rapidly in group TSA. The dosage of intravenous ephedrine was used successfully to treat hypotension in both groups (more in the TSA group than in the TEA group) because of the limitations of intravenous fluid usage in COPD patients. We also found that a reduction in postoperative pain and a decreased need for postoperative analgesics for 12 hours were linked to both TSA and TEA anesthesia. Compared to the TSA group, the TEA group needed a longer time to reach the T6 level. There were no severe adverse effects that caused the patients any discomfort; instead, the side effects were comparable. In both groups, patient and surgeon satisfaction was roughly the same. This could be explained by reduced adverse effects, improved postoperative mobility, and improved postoperative analgesia. During the trial, several participants in both groups experienced mild unwanted side effects such as bradycardia, vomiting, pruritus, and respiratory depression. However, hypotension was more common in the TEA group than in the TSA group, which only used thoracic epidural anesthesia. Despite these drawbacks, the majority of patients and surgeons in both groups reported either excellent or good levels of satisfaction. Patients in both groups also experienced fewer complications and a shorter length of stay in the ICU after surgery.

According to a prospective randomized clinical experiment by **Nandanwar *et al.*[7]**, segmental epidural block outperforms spinal anesthesia in terms of hemodynamic stability when compared to thoracic spinal block. The spinal group's postoperative VAS score was substantially greater, and the difference was very significant four hours later.

In their investigation of the effects of combined spinal epidural anesthesia versus general anesthesia, **Singh *et al.* [8]** found that the spinal epidural group experienced shorter hospital stays, lower VAS scores, and less need for analgesics.

In terms of operative time, postoperative hemoglobin level, hospital stay, success rate, and postoperative complications, **Kuzgunbay *et al.* [9]** compared spinal epidural anesthesia and general anesthesia. They found no differences between the two, except for patient satisfaction, which was higher with spinal epidural block.

In their comparison of general anesthesia and combined spinal-epidural (CSE) anesthesia for percutaneous nephrolithotomy, **Bürlukkara *et al.* [10]** discovered that the CSE group's VAS was considerably lower than the general anesthesia group's during the postoperative phase. Compared to the CSEA group, surgeon satisfaction was higher in the general anesthesia group. However, CSEA was associated with a higher patient satisfaction.

Dar *et al.*[11] performed PCNL under epidural as opposed to general anesthesia and found that the EA group experienced considerably lower visual analog pain scores in the early postoperative period than the GA group. **Nandanwar *et al.*[7]** recently compared spinal epidural anesthesia (SEA) and spinal anesthesia (SA) for PCNL and found that the SEA technique is superior in terms of hemodynamics, positioning, postoperative analgesia, patient satisfaction, and PONV. When **Parikh *et al.* [6]** compared general anesthesia and segmental epidural anesthesia (SEA) in PCNL, they found that although the two groups' baseline hemodynamics were comparable, there was a significant difference in their heart rates from 0 to 120 minutes, with the mean heart rate of group GA being higher than that of group SEA. After induction, group SEA saw a statistically significant drop in MAP from its baseline value. There were no appreciable changes observed when MAP was examined between groups at the same time points.

In the study of **Srinivasa *et al.* [12],** the two groups' mean intraoperative blood pressures at five, ten, fifteen, and thirty minutes were comparable, there was no statistically significant difference between the two groups at any of the time points. However, the blood pressure of the GA group was consistently higher than that of the SA group. There were no statistically significant differences in analgesic needs, patient satisfaction, or blood loss during surgery. Compared to patients in the GA group, patients in the SA group reported higher levels of overall satisfaction.

Karacalar *et al.* [13] claim that the combination SEA outperformed GA in terms of reducing postoperative pain, reducing the length of time patients needed to take analgesic drugs after surgery, and improving patient satisfaction. There were no significant differences in itching, vomiting, bradycardia, or hypotension between the two groups, however, the GA group had a higher rate of nausea. However, GA and SEA did not differ in terms of operating duration, postoperative hemoglobin level,

hospital stay, success rate, or postoperative complications.

Mehrabi and Shirazi [14] evaluated PCNL in the prone position under SA. According to their findings, PCNL is a method that can be applied under SA in lieu of GA. However, when the patient was transferred from a supine position to a prone one, other studies did not detect hemodynamic instability. However, it has been noted that spinal epidural blocks improve patient satisfaction.

Kuzgunbay *et al.* [9] examined the safety and efficacy of PCNL under GA and CSEA. They concluded that PCNL under GA was no longer safe or effective than PCNL under CSEA.

According to **Tangpaitoon *et al.*** [15], EA offered a few advantages over GA, such as lower rates of nausea and vomiting, postoperative discomfort, the need for analgesic medications, and higher patient satisfaction. SEA outperformed SA in terms of hemodynamic stability, postoperative analgesia, patient satisfaction, and decreased incidence of nausea and vomiting so the SEA approach is superior according to **Nandanwar *et al.*** [7]**.** Group SEA exhibited better patient outcomes, according to **Parikh *et al.*** [6]. Group GA patients had similar mean arterial pressures, and their heart rates were substantially greater. Group GA had a longer delay to first rescue analgesia and consumed more tramadol overall after surgery. Pain scores were lower in group SEA. Group GA experienced a higher incidence of nausea, whereas vomiting rates were similar. Bradycardia was successfully treated in one of the SEA group's patients. In group GA, eight patients (18%) experienced hypertensive episodes, while in group SEA, none did. An intercostal drain was used to treat a patient in the GA group who had pleural damage. In both groups' satisfaction, stone clearance and postoperative hemoglobin levels were similar.

In our results, there was a statistically significant difference between the two groups in the time it took for the sensory block to go away, as measured by the first rescue analgesic dose. The duration was shorter in the TSA group and longer in the TEA group. We found no significant difference in oxygenation during surgery or CO_2 clearance afterward. Because of Venturi 60% oxygen system, both the intraoperative and the postoperative PaO_2 readings were greater than the preoperative baseline values.

Patients with COPD undergoing major abdominal surgery have received little attention in studies examining the effect of neuroaxial anesthesia on pulmonary function tests (PFT). Factors such as the block's level and intensity, the type of block, and the severity of COPD; all have an impact on PFT [20]. Our PFT was consistent with the results of a prior study done by **Warner *et al.*** [16]**,** showing a decrease in the inspiratory capacity and expiratory reserve volume between 20% and 10% during T6 neuroaxial anesthesia. However, in patients with unintentional neuroaxial block extension to cervical level diaphragmatic function is frequently preserved. When COPD patients undergoing elective transurethral surgery received an intrathecal injection of either 0.5% hyperbaric bupivacaine or 0.5% isobaric levobupivacaine, **Sahin *et al.*** [17] found no discernible variations in pulmonary function. On the other hand, thirty minutes after baseline, hyperbaric bupivacaine reduced intraoperative PEFR. According to a study by **Lumb and Biercamp** [1]**,** 60% of patients with COPD who got EA in addition to general anesthesia also underwent major abdominal surgery. Patients who received EA had a lower 30-day death rate and a lower incidence of postoperative pneumonia.

The use of regional anesthesia in patients with COPD is linked to lower incidences of composite morbidity, pneumonia, prolonged ventilator dependence, and unplanned postoperative intubation, according to **Hausman *et al.*'s** [18] comparison of the effects of regional anesthesia versus general anesthesia.

However, previous studies have shown that patients with COPD and those with normal lung function don't benefit from lumbar neuroaxial anesthesia for lower abdominal and lower limb surgery in terms of improved PFT. However, it was found that patients with morbid obesity had a decrease in expiratory functional volumes of about 20-25% [19], including forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC). **Santhosh and co-workers** studied eight people with advanced lung disease. These patients underwent abdominal surgery while under an epidural block at the T4-T6 level, and the surgery was completed successfully. Additionally, in COPD patients who have had numerous episodes of stress-related pneumothorax, a combination of lumbar spinal and thoracic epidural anesthesia is a viable primary anesthetic strategy for nephrectomy [20].

Higher levels of lumbar spinal and thoracic epidural anesthesia were found to reduce expiratory force in some patients, especially those with GOLD 2 and 3 categories. According to **Savas *et al.*** [21] they documented results that are at odds with these ones. Patients in the current trial required non-invasive breathing or were changed to GA, although neither of these outcomes was reported in the studies by **Savas *et al.*** [21]. It's worth noting that just eight patients were included in their study, and those patients had different surgical and pulmonary demands than the patients in the current study. Higher doses of local anesthetics were administered to the thoracic region in the TEA group, which may explain why patients in this group required non-invasive ventilation assistance more often than those in the TSA group. Motor blockage of the abdominal and intercostal muscles may have been more significant in these greater doses. During surgery, it is crucial to keep a close eye on the patient's breathing pattern, oxygen levels (oximetry), arterial

blood gas analysis, auscultation of the chest, and administration of bronchodilator therapy if necessary, especially in patients prone to bronchospasm.

It has been shown that an increase in postoperative discomfort and a decrease in forced expiratory volume in one second (FEV1) can come from the inability of the clearance of bronchial secretion in the postoperative phase. Chest physiotherapy procedures including chest percussion, deep breathing exercises, and encouraging coughing and expectoration were used alongside strong postoperative analgesics to manage this problem. These steps were taken to reduce the likelihood of these issues occurring.

CONCLUSION

In patients with COPD, thoracic spinal anesthesia and thoracic epidural anesthesia can be employed as the exclusive neuroaxial anesthesia approach and for postoperative analgesia during supine position endoscopic PCNL treatments for kidney stones. The current analysis highlights TSA and TEA's benefits and recommends their deployment. TSA causes less hemodynamic instability, is simpler to start, produces a more consistent block, and has less technical issues than other occlusion techniques. Preoperative lung function optimization, intraoperative monitoring, postoperative neuroaxial analgesia, and chest physical therapy are all essential components of a multifaceted strategy to improve surgical outcomes. In situations where general anesthesia is not the best option, segmental thoracic spinal or segmental epidural blocks are both suitable substitutes with a minimal risk of complications and high patient satisfaction.

LIMITATIONS

The study's primary drawback was that it only comprised a subset of patients and skilled surgeons. Even when noninvasive ventilatory support was offered, high intensity neuroaxial blockage was likely to cause respiratory distress in patients with COPD.

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