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Comparative Analysis of Sevoflurane and Isoflurane Effects on Hemodynamic Stability and Postoperative Recovery in Neurosurgical Procedures

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ABSTRACT:

Background: The choice of anesthetic agents in neurosurgical procedures plays a crucial role in patient outcomes. This study aimed to compare the effects of Sevoflurane and Isoflurane on intra-operative hemodynamic response to stimulus, degree of brain swelling (secondary outcome), and early post-operative recovery outcomes.

Methods: A prospective comparative study was conducted involving two groups: Group S (Sevoflurane) and Group I (Isoflurane). The study included 60 patients undergoing neurosurgical procedures. Hemodynamic stability was assessed by measuring heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) at various time points, including baseline, intubation, pin insertion, incision, post-operation, closure, pin removal, extubation, and post-extubation. The emergence time, extubation time, Aldrete Score (indicative of recovery), Brain Relaxation Score (reflecting brain relaxation during the procedure), and adverse events were also recorded to evaluate postoperative outcomes.

Results: Sevoflurane demonstrated significantly shorter emergence and extubation times compared to Isoflurane, indicating a faster recovery and smoother restoration of airway reflexes. Sevoflurane also resulted in a shorter time to achieve an Aldrete Score greater than 8, reflecting a quicker postoperative recovery. Both Sevoflurane and Isoflurane exhibited comparable effectiveness in achieving optimal brain relaxation, as indicated by the similar Brain Relaxation Scores. The incidence of adverse events, including nausea/vomiting and shivering, was similar between the two groups, indicating comparable tolerability. Hemodynamic analysis revealed significant differences in heart rate, SBP, DBP, and MAP between the two groups at different time points, suggesting distinct effects on hemodynamics during the procedure.

Conclusion: This prospective comparative study provides evidence of the differential effects of Sevoflurane and Isoflurane on hemodynamic stability, including heart rate, SBP, DBP, and MAP, as well as postoperative outcomes in neurosurgical procedures. Sevoflurane demonstrated advantages in terms of faster recovery, smoother airway reflex restoration, and quicker postoperative recovery compared to Isoflurane. The comparable effectiveness in achieving optimal brain relaxation and similar tolerability between the two agents indicate their overall suitability for neurosurgical anesthesia. However, the observed differences in hemodynamic parameters, including MAP, emphasize the importance of individualized anesthetic management to ensure optimal patient care. Further research with larger sample sizes and long-term outcome assessments is recommended to validate these findings and explore the cost-effectiveness of Sevoflurane and Isoflurane in neurosurgical settings.

1. Introduction

Intracranial surgery is a specialized discipline that encompasses a wide range of procedures performed within the brain. It includes tumor resections, aneurysm repairs, epilepsy surgeries, shunt placements, and treatments for traumatic brain injuries, among others. Pain and hemodynamic complications are common challenges encountered during intracranial surgery. Pain management is particularly critical due to the high sensitivity of cranial structures and the potential stimulation of nociceptive receptors during surgical manipulations. Inadequate pain control can result in patient discomfort, increased stress response, and possible complications. [1, 2] Hemodynamic instability, characterized by fluctuations in blood pressure, heart rate, and intracranial pressure, poses a risk to cerebral perfusion and may lead to ischemia and adverse neurological outcomes. [3] Hence, effective pain management and the maintenance of hemodynamic stability are essential considerations in these complex surgeries. Inhalation anesthesia, with its analgesic properties and the ability to regulate hemodynamics, plays a significant role in alleviating pain by attenuating nociceptive stimuli and ensuring optimal brain

perfusion through precise titration of the anesthetic depth. [4, 5] Inhalation anesthesia also promotes vasodilation, reduces myocardial contractility and heart rate, regulates cerebral blood flow, and maintains appropriate carbon dioxide levels, thereby minimizing the risk of complications during craniotomy procedures. [6]

Inhaled anesthetics act on the central nervous system by affecting the communication between nerve cells in several ways. They interfere with the release of neurotransmitters, modify the re-uptake of neurotransmitters, alter the binding of neurotransmitters to receptor sites, and influence the conductance of ions across cell membranes. These actions disrupt normal synaptic transmission, either enhancing or depressing excitatory or inhibitory signals. [7]

Sevoflurane and isoflurane are widely used inhalation anesthetic agents in clinical practice due to their favorable properties, including good cerebral elimination, low blood solubility, rapid uptake and elimination from the brain tissue. [8] Sevoflurane is a volatile inhalation anesthetic that is widely used due to rapid onset and offset of action, allowing for precise control and adjustment of anesthesia depth. Sevoflurane gets metabolized in the liver through hepatic biotransformation, resulting in the production of inorganic fluoride ions which readily gets eliminated mainly through the kidneys. This allows for faster recovery and emergence from anesthesia. [9] Isoflurane is another choice of inhalation anesthetic with similar properties to sevoflurane which also has a rapid onset and offset of action, making it suitable for various surgical procedures. Isoflurane undergoes minimal biotransformation in the body and unlike sevoflurane, it does not produce significant levels of metabolites. The elimination of isoflurane occurs mainly through exhalation, as it is expelled from the body primarily through the lungs. Both sevoflurane and isoflurane share common mechanism of action by enhancing the inhibitory activity of the neurotransmitter gamma-aminobutyric acid (GABA) in the central nervous system. [10] They potentiate the effect of GABA at its receptors, resulting in the suppression of neuronal activity and the induction of anesthesia. Rapid induction and recovery, faster operating room turnover times, and shorter recovery room stays are essential factors in an ideal inhalation anesthetic. [11] Intra-operatively, the hemodynamic response to surgical stimuli is a crucial parameter to assess the stability of the patient's cardiovascular system during the procedure. The aim of this study is to compare the effects of isoflurane and sevoflurane, two commonly used inhalation anesthetic agents, on intra-operative hemodynamic response to stimulus, degree of brain swelling (secondary outcome), and early post-operative recovery outcomes.

2. Materials and Methods:

Study Design:

This prospective, randomized study was conducted at the Department of Anesthesia, Gujarat Cancer and Research Institute, Ahmedabad, during the period of 2017-2018.

Participants:

A total of 60 cases of ASA Grade I-II patients, aged 18-65 years, of either sex, scheduled to undergo an elective supratentorial craniotomy, were included in the study. Institutional ethical committee approval was obtained, and written informed consent was obtained from each patient. Exclusion criteria included previous craniotomy, pregnancy and lactation, hepatic or renal disorders, midline shift >5mm, GCS <15, BMI >35kg/m2, surgery duration exceeding 3 hours, alcohol/drug abuse, and patients planned for post-operative ventilation. The patients included in the study were randomly allocated to two groups: Group S, which received Sevoflurane, and Group I, which received Isoflurane. The inhalation anesthetic agents were administered at a dose ranging from 0.8 to 1.2 minimum alveolar concentration (MAC).

Preparation and Monitoring: On the day of surgery, patients were instructed to continue their regular medications with sips of water. Baseline vital signs, including ECG, heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and peripheral oxygen saturation (SpO2), were recorded upon arrival in the operation theatre. Gender, age, body weight, and duration of operation for each case were also recorded. Premedication included intravenous injections of Glycopyrrolate (0.004 mg/kg), Ondansetron (0.1 mg/kg), Ranitidine (1 mg/kg), Paracetamol (15 mg/kg), and antiepileptic medication (Inj. Levetiracetam, 10 mg/kg).

Anesthesia Induction and Maintenance: Patients were preoxygenated with 100% oxygen and induced with intravenous injections of Fentanyl citrate (2 µg/kg), Thiopentone Sodium (5 mg/kg), Vecuronium Bromide (0.1 mg/kg), and Lignocaine (2% 1.5 mg/kg) administered 1.5 minutes before intubation. Endotracheal intubation was performed, and anesthesia was maintained using nitrous oxide (1 L/min) and oxygen (1 L/min), along with the assigned inhalation agent (Sevoflurane or Isoflurane) at a MAC of 0.8-1.2%. Vecuronium infusion was started at a rate of 1 microgram/kg/min after intubation and titrated using a neuromuscular monitor.

Surgical Procedure and Monitoring: Before applying the skull pin, local infiltration of 8-10 ml of Lignocaine (2%) was performed at the skin incision site. All patients were mechanically ventilated on a volume control mode, maintaining tidal volume at 8-10 ml/kg and respiratory rate at 12-16/min to maintain end-tidal CO2 levels between 30-35 mmHg. Mannitol (1 gram/kg) and dexamethasone (0.1 mg/kg) were given before opening the Dura. The brain swelling status was evaluated by the surgeon, who was blinded to the anesthetic agent used, using the brain relaxation score defined by TODD et al. The score included four categories: 1) Perfect relaxation, 2) Satisfactory relaxation, 3) Firm brain, and 4) Tight brain. If the brain was tight or firm according to the surgeon's assessment, interventions such as changing head position, hyperventilation, or administration of additional Mannitol (0.5 g/kg) and Furosemide (0.1 mg/kg) were performed.

Rescue Drugs:
Hypertension, defined as a mean arterial pressure (MAP) greater than 20% of the baseline value, was addressed by increasing the inhalation agent to 1.2 minimum alveolar concentration (MAC) or administering an intravenous injection of Propofol at a dose of 1 mg/kg. On the other hand, hypotension, characterized by an MAP lower than 20% of the baseline value, was managed by reducing the inhalation agent to 0.8 MAC, increasing the rate of crystalloid infusion, or administering an intravenous injection of Phenylephrine at a dose of 50 micrograms. In the case of bradycardia, defined as a heart rate (HR) lower than 20% of the baseline value, an intravenous injection of Atropine Sulphate was given at a dose of 0.02 mg/kg. Tachycardia, marked by an HR higher than 20% of the baseline value, was addressed with an intravenous injection of Esmolol at a dose of 1-2 mg/kg.

Emergence and Postoperative Care: After completion of the surgical procedure, patients were extubated once they exhibited sufficient respiratory and spontaneous activity. The emergence time (time from stopping inhalational anesthetics to eye opening), extubation time (time between discontinuation of inhalational anesthetic and tracheal extubation), recovery time (time between discontinuation of inhalational anesthetics and when patients were able to recall their names and date of birth), and time to reach an Aldrete Score >8 were recorded. Postoperative care and monitoring of hemodynamic parameters and postoperative

complications, such as shivering and nausea-vomiting, were conducted in the postoperative ward.

Determination of Aldrete Score: The recovery of patients from anesthesia was assessed using the Aldrete Score, which takes into account five key parameters: activity, respiration, circulation, consciousness, and color. Each parameter is evaluated and assigned a score, resulting in a total score ranging from 0 to 10. A score greater than 8 is considered indicative of sufficient recovery and readiness for discharge from the post-anesthesia care unit.

Data Analysis: Continuous variables were analyzed using independent t-tests, while categorical nominal data were analyzed using chi-square tests. Statistical analysis was performed using Graph Pad software, and a p-value <0.05 was considered statistically significant."

3. Results:

Table 1 shows the demographic profile of the patients. The mean age in group S was 42.53±13.26 where as in group I it was 47.3±10.42. The mean weight of the patient in Group S and I was 45.66±7.28 and 47.23±7.43 respectively. The male to female ratio in group S was 21:9 compared to 18:12 in group I. The duration of Anaesthesia in group S was 157.2±30.63 and group I was 155.4±31.53. There was no significant difference in P value as value was higher than 0.05.

Table 1: Demographic profile of the patients

Parameter	Group S (Mean± SD)	Group I (Mean± SD)	P-VALUE
Age (Years)	42.53±13.26	47.3±10.42	0.1 (NS)
Weight (Kg)	45.66±7.28	47.23±7.43	0.4 (NS)
Sex (M/F)	21/9	18/12	0.2 (NS)
Duration of Anesthesia	157.2±30.63	155.4±31.53	0.9 (NS)

A comparison was made between Group S and Group I for heart rate during the procedure (Table 2). The baseline measurements showed a significant difference, with Group S having a mean of 81.06±11.12 and Group I having a mean of 76±6.59 (p=0.03). The intubation phase also exhibited a significant difference, with Group S having a mean of 78.3±9.72 and Group I having a mean of 70.9±5.09 (p<0.0001). Similarly, the pin insertion phase showed a significant difference, with Group S having a mean of 82.46±7.6 and Group I having a mean of 74.33±4.38 (p<0.0001). No significant differences were observed during the incision phase (Group S: 79.7±7.86, Group I: 76.3±5.09; p=0.5) and at 30 minutes post-operation (Group S: 76.56±6.56, Group I: 72.96±7.94; p=0.06). However, a significant difference was noted at 60 minutes post-operation, with Group S having a mean of 78.23±6.92 and Group I having a mean of 72.03±5.91 (p=0.0004). No significant differences were observed at 90 minutes (Group S: 78.06±6.65, Group I: 77.55±8.63; p=0.7), 120 minutes (Group S: 74.66±5.6, Group I:

76.31±7.9; p=0.35), 150 minutes (Group S: 74±4.61, Group I: 72.77±4.95; p=0.32), and 180 minutes (Group S: 80±3.66, Group I: 76.08±8.61; p=0.37).
No significant differences were found during the closure phase (Group S: 80.13±7.62, Group I: 78.66±3.14; p=0.3), pin removal phase (Group S: 82.96±7.6, Group I: 80.3±7.003; p=0.16), extubation phase (Group S: 84.03±6.78, Group I: 81.66±6.04; p=0.15), post-extubation phase (Group S: 80±4.82, Group I: 83.15±6.51; p=0.4924). However, a significant difference was observed at the post-op 1-hour mark, with Group S having a mean of 85.53±3.81 and Group I having a mean of 73.5±5.29 (p<0.0001).

Table 2: Analysis of Heart Rate (bpm) at different time interval in both groups

Parameter	Group S (Mean± SD)	Group I (Mean ± SD)	P-VALUE
Baseline	81.06±11.12	76±6.59	0.03 (Significant)
Intubation	78.3±9.72	70.9±5.09	<0.0001 (Significant)
Pin Insertion	82.46±7.6	74.33±4.38	<0.0001 (Significant)
Incision	79.7±7.86	76.3±5.09	0.5 (NS)
30 Minutes	76.56±6.56	72.96±7.94	0.06 (NS)
60 Minutes	78.23±6.92	72.03±5.91	0.0004 (Significant)
90 Minutes	78.06±6.65	77.55±8.63	0.7 (NS)
120 Minutes	74.66±5.6	76.31±7.9	0.35 (NS)
150 Minutes	74±4.61	72.77±4.95	0.32 (NS)
180 Minutes	80±3.66	76.08±8.61	0.37 (NS)
Closure	80.13±7.62	78.66±3.14	0.3 (NS)
Pin Removal	82.96±7.6	80.3±7.003	0.16 (NS)
Extubation	84.03±6.78	81.66±6.04	0.15 (NS)
Post Extubation	80 ±4.82	83.15 ±6.51	0.4924 (NS)

Post Op 1 Hour	85.53±3.81	73.5 ±5.29	<0.0001 (Significant)

Table 3 presents a comparison of systolic blood pressure (SBP) measurements in both Group S and Group I at various time points. The baseline SBP showed no significant difference between the groups, with Group S having a mean SBP of 127.23±13.37 mmHg and Group I having a mean SBP of 130.76±6.14 mmHg (p=0.1940, non-significant). During the intubation phase, there was a significant difference in SBP, with Group S having a mean SBP of 120.83±11.30 mmHg and Group I having a mean SBP of 115.7±7.66 mmHg (p=0.0441, significant). Significant differences in SBP were observed during pin insertion (Group S: 130.16±9.47 mmHg, Group I: 121.2±6.42 mmHg; p<0.0001), incision (Group S: 127.70±8.37 mmHg, Group I: 119.26±5.13 mmHg; p<0.0001), and at 30 minutes post-operation (Group S: 116.06±9.12 mmHg, Group I: 109.2±6.22 mmHg; p=0.0012). ignificant differences in SBP were also found at 60 minutes (Group S: 119.8±11.09 mmHg, Group I: 109.2±6.82 mmHg; p<0.0001), 90 minutes (Group S: 118.16±7.05 mmHg, Group I: 111.25±4.75 mmHg; p=0.0002), 120 minutes (Group S: 122.33±6.56 mmHg, Group I: 112.36±6.17 mmHg; p<0.0001), 150 minutes (Group S: 127±6.37 mmHg, Group I: 113.05±5.13 mmHg; p<0.0001), 180 minutes (Group S: 126±5.14 mmHg, Group I: 115.91±3.80 mmHg; p=0.0007), closure (Group S: 123.7±5.74 mmHg, Group I: 116.23±6.66 mmHg; p<0.0001), pin removal (Group S: 126.83±6.94 mmHg, Group I: 122.03±5.99 mmHg; p=0.0058), extubation (Group S: 133.56±7.89 mmHg, Group I: 127.56±7.77 mmHg; p=0.0044), post-extubation (Group S: 125.83±6.54 mmHg, Group I: 122.3±6.65 mmHg; p=0.0426), and at the post-operative 1-hour mark (Group S: 123.9±5.68 mmHg, Group I: 121.±4.24 mmHg; p=0.0289).

Table 3: Analysis of SBP at different time interval in both groups

Parameter	Group S (Mean± SD)	Group I (Mean± SD)	P-VALUE
Baseline	127.23±13.37	130.76±6.14	0.1940 (ns)
Intubation	120.83±11.30	115.7±7.66	0.0441 (significant)
Pin insertion	130.16±9.47	121.2±6.42	<0.0001 (significant)
Incision	127.70±8.37	119.26±5.13	<0.0001 (significant)
30 Minutes	116.06±9.12	109.2±.6.22	0.0012 (significant)
60 Minutes	119.8±11.09	109.2±6.82	<0.0001 (significant)
90 Minutes	118.16±7.05	111.25±4.75	0.0002 (significant)
120 Minutes	122.33±6.56	112.36±6.17	<0.0001 (significant)
150 Minutes	127±6.37	113.05±5.13	<0.0001 (significant)

180 Minutes	126±5.14	115.91±3.80	0.0007 (significant)
Closure	123.7±5.74	116.23±6.66	<0.0001 (significant)
Pin Removal	126.83±6.94	122.03±5.99	0.0058 (significant)
Extubation	133.56±7.89	127.56±7.77	0.0044 (significant)
Post Extubation	125.83±6.54	122.3±6.65	0.0426 (significant)
Post op 1 hour	123.9±5.68	121.±4.24	0.0289 (significant)

Table 4 displays a comparison of diastolic blood pressure (DBP) measurements between Group S and Group I at various time points. The baseline DBP did not show a significant difference between the groups, with Group S having a mean DBP of 79.66±10.91 mmHg and Group I having a mean DBP of 77.13±6.38 mmHg (p=0.2, non-significant). During the intubation phase, there was a significant difference in DBP, with Group S having a mean DBP of 82.53±8.15 mmHg and Group I having a mean DBP of 71.33±7.8 mmHg (p<0.0001, significant). Significant differences in DBP were observed during pin insertion (Group S: 78.33±6.21 mmHg, Group I: 75.26±4.37 mmHg; p=0.0307), incision (Group S: 74.26±7.12 mmHg, Group I: 78.66±4.73 mmHg; p=0.0066), and at 30 minutes post-operation (Group S: 76.73±7.1 mmHg, Group I: 73.12±5.23 mmHg; p=0.0288). Significant differences in DBP were also found at 60 minutes (Group S: 76.73±7.11 mmHg, Group I: 72.53±5.21 mmHg; p=0.0115), 90 minutes (Group S: 75.26±4.96 mmHg, Group I: 71.73±4.18 mmHg; p=0.0042), 120 minutes (Group S: 77.33±5.3 mmHg, Group I: 73.09±4.30 mmHg; p=0.003), 150 minutes (Group S: 77±4.61 mmHg, Group I: 73.6±3.06 mmHg; p=0.0114), 180 minutes (Group S: 82±3.53 mmHg, Group I: 73±9.58 mmHg; p=0.0109), closure (Group S: 79.1±6.69 mmHg, Group I: 75.80±5.33 mmHg; p=0.0389), pin removal (Group S: 80.46±5.52 mmHg, Group I: 76.36±5.57 mmHg; p=0.0058), extubation (Group S: 83.99±8 mmHg, Group I: 79.66±5.13 mmHg; p=0.0154), post-extubation (Group S: 76.56±4.91 mmHg, Group I: 80.76±6.33 mmHg; p=0.0057), and at the post-operative 1-hour mark (Group S: 75.18±4.43 mmHg, Group I: 79.9±6.7 mmHg; p=0.0021).

Table 4: Analysis of DBP at different time interval in both groups

Parameter	Group S (Mean± SD)	Group I (Mean± SD)	P-VALUE
Baseline	79.66±10.91	77.13±6.38	0.2 (NS)
Intubation	82.53±8.15	71.33±7.8	<0.0001 (Significant)
Pin insertion	78.33±6.21	75.26±4.37	0.0307 (Significant)
Incision	74.26±7.12	78.66±4.73	0.0066 (Significant)
30 Minutes	76.73±7.1	73.12±5.23	0.0288 (Significant)

60 Minute	76.73±7.11	72.53±5.21	0.0115 (Significant)
90 Minutes	75.26±4.96	71.73±4.18	0.0042 (Significant)
120 Minutes	77.33±5.3	73.09±4.30	0.003 (Significant)
150 Minutes	77±4.61	73.6±3.06	0.0114 (Significant)
180 Minutes	82±3.53	73±9.58	0.0109 (Significant)
Closure	79.1±6.69	75.80±5.33	0.0389 (Significant)
Pin Removal	80.46±5.52	76.36±5.57	0.0058 (Significant)
Extubation	83.99±8	79.66±5.13	0.0154 (Significant)
Post Extubation	76.56±4.91	80.76±6.33	0.0057 (Significant)
Post op 1 hour	75.18±4.43	79.9±6.7	0.0021 (Significant)

Table 5 presents a comparison of mean arterial pressure (MAP) measurements between Group S and Group I at different time points. The baseline MAP did not exhibit a significant difference between the groups, with Group S having a mean MAP of 95.8±9.64 mmHg and Group I having a mean MAP of 95±4.66 mmHg (p=0.6839, non-significant). During the intubation phase, there was a significant difference in MAP, with Group S having a mean MAP of 70.23±11.24 mmHg and Group I having a mean MAP of 86.13±6.13 mmHg (p<0.0001, significant). Significant differences in MAP were observed during pin insertion (Group S: 99.46±8.80 mmHg, Group I: 90.53±4.56 mmHg; p<0.0001), incision (Group S: 94.86±5.04 mmHg, Group I: 91.93±3.89 mmHg; p=0.0145), and at 30 minutes post-operation (Group S: 88.63±6.60 mmHg, Group I: 85.13±4.89 mmHg; p=0.0231). Significant differences in MAP were also found at 60 minutes (Group S: 91.96±8.48 mmHg, Group I: 84.2±4.27 mmHg; p<0.0001), 90 minutes (Group S: 89.76±4.46 mmHg, Group I: 87.14±4.88 mmHg; p=0.0471), 120 minutes (Group S: 92.66±5.88 mmHg, Group I: 87.59±6.06 mmHg; p=0.0061), 150 minutes (Group S: 94±4.73 mmHg, Group I: 89.44±7.05 mmHg; p=0.0214), and 180 minutes (Group S: 97±3.63 mmHg, Group I: 88.3±7.66 mmHg; p=0.0037). Additionally, there were significant differences in MAP during closure (Group S: 94.9±7.21 mmHg, Group I: 93.26±5.11 mmHg; p<0.0001) and pin removal (Group S: 97.03±7.88 mmHg, Group I: 91.86±5.09 mmHg; p=0.0038). The difference in MAP between the groups during extubation was also significant, with Group S showing a mean MAP of 100.76±6.6 mmHg and Group I showing a mean MAP of 95.73±4.98 mmHg (p=0.0015). However, there were no significant differences in MAP at the post-extubation time point (Group S: 95.3±3.85 mmHg, Group I: 94.53±5.13 mmHg; p=0.5134) and at the post-operative 1-hour mark (Group S: 91.36±4.12 mmHg, Group I: 93.7±5.16 mmHg; p=0.0571).

Table 5: Analysis of Mean arterial pressure at different time interval in both groups

Parameter	Group S (Mean± SD)	Group I (Mean± SD)	P-VALUE

Baseline	95.8±9.64	95±4.66	0.6839 (NS)
Intubation	70.23±11.24	86.13±6.13	0.0001 (Significant)
Pin insertion	99.46±8.80	90.53±4.56	<0.0001 (Significant)
Incision	94.86±5.04	91.93±3.89	0.0145 (Significant)
30 Minutes	88.63±6.60	85.13±4.89	0.0231 (Significant)
60 Minute	91.96±8.48	84.2±4.27	<0.0001 (Significant)
90 Minutes	89.76±4.46	87.14±4.88	0.0471 (Significant)
120 Minutes	92.66±5.88	87.59±6.06	0.0061 (Significant)
150 Minutes	94±4.73	89.44±7.05	0.0214 (Significant)
180 Minutes	97±3.63	88.3±7.66	0.0037 (Significant)
Closure	94.9±7.21	93.26±5.11	<0.0001 (Significant)
Pin Removal	97.03±7.88	91.86±5.09	0.0038 (Significant)
Extubation	100.76±6.6	95.73±4.98	0.0015 (Significant)
Post Extubation	95.3±3.85	94.53±5.13	0.5134 (NS)
Post op 1 hour	91.36±4.12	93.7±5.16	0.0571 (NS)

Table 6 displays the comparison of emergence time and extubation time between Group S and Group I. The mean emergence time in Group S was 14.16±4.29 minutes, while in Group I it was 16.7±3.79 minutes, resulting in a significant difference between the groups (p=0.0182, significant). Regarding extubation time, Group S had a mean time of 21.43±4.5 minutes, whereas Group I had a mean time of 24.5±4.62 minutes. The analysis revealed a significant difference in extubation time between the two groups (p<0.01, significant).

Table 6: Comparison of Emergence and Extubation time in both the groups

Parameter	Group S (Mean± SD)	Group I (Mean± SD)	P-VALUE
Emergence Time (Minutes)	14.16±4.29	16.7±3.79	0.0182 (Significant)
Extubation Time (Minutes)			
Extubation Time	21.43±4.5	24.5±4.62	<0.01 (Significant)

In Table 7, the comparison of Aldrete Score and Brain Relaxation Score between Group S and Group I is presented. The mean time to reach an Aldrete Score greater than 8 in Group S was 29.6±5.69 minutes, while in Group I it was 33.63±4.01 minutes. The analysis revealed a significant difference in the time to reach Aldrete Score > 8 between the two groups (p<0.0001, significant). Regarding the Brain Relaxation Score, Group S had a mean score of 1.13±0.3457, whereas Group I had a mean score of 1.23±0.50. However, the statistical analysis did not show

a significant difference in Brain Relaxation Score between the two groups (p=0.3713, not significant).

Table 7: Comparison of Aldrete Score and Brain Relaxation Score in both the groups

Parameter	Group S (Mean± SD)	Group I (Mean± SD)	P-VALUE
Time to Reach Aldrete Score > 8 (Minutes)	29.6±5.69	33.63 ±4.01	<0.0001 (Significant)
Brain Relaxation Score (Minutes)			
Brain Relaxation Score	1.13±0.3457	1.23±0.50	0.3713 (NS)

Table 8 presents the occurrence of adverse events reported in both Group I and Group S. In Group I, out of the total participants, 2 (7%) individuals experienced nausea/vomiting, while 4 (13%) individuals reported shivering. In Group S, 3 (10%) individuals reported nausea/vomiting, and 2 (7%) individuals experienced shivering.

Table 8: Adverse Event reported in both the Groups

Adverse Event	Group I N (%)	Group S N (%)
Nausea/ Vomiting	2 (7)	3 (10)
Shivering	4 (13)	2 (7)

4. Discussion

In recent years, comparative studies evaluating the effects of different anesthetic agents in specific surgical procedures have gained importance in clinical practice. These studies aim to provide valuable insights into the selection of anesthetic agents and their impact on patient outcomes. Understanding the differences and similarities between different anesthetic agents is crucial for optimizing patient care, enhancing surgical outcomes, and ensuring patient safety. Neurosurgical procedures, such as supratentorial craniotomy, are complex and delicate surgeries that require meticulous anesthesia management. The choice of anesthetic agent plays a pivotal role in maintaining stable hemodynamics, ensuring adequate analgesia, and minimizing complications during and after the surgery. Inhalation anesthetics, such as Sevoflurane and Isoflurane, are commonly used in neurosurgical procedures due to their favorable pharmacokinetic profiles and controllable depth of anesthesia. Demographic factors such as age, weight, sex distribution, and duration of anesthesia were analyzed to assess any potential differences between the two groups. Factors such as age and weight may affect the pharmacokinetics and pharmacodynamics of anesthetic agents, which can influence drug dosing, clearance, and overall anesthesia management. The mean age of patients in Group S was 42.53±13.26 years, while in Group I it was 47.3±10.42 years. Although the mean age was slightly higher in Group I, the difference was not statistically significant (P=0.1, non-significant) indicating age as a non-significant parameter that influence the choice of inhalation anesthetic agent. Further evaluating the demographic profile of patients no significant differences in sex distribution and duration of anesthesia was observed between both the groups indicating that the choice of inhalation anesthetic agent does not significantly impact the duration of anesthesia and is not influenced by sex in supratentorial craniotomy cases. The results of present study aligns with the findings of reported studies indicating no significant differences in age, weight, sex distribution, or duration of anesthesia among patients in both groups. [12, 13]

In present study, we compared the heart rate (HR) between patients receiving Sevoflurane (Group S) and Isoflurane (Group I) during different phases of the procedure. Significant differences in HR were observed at various time points. Baseline HR measurements showed a significant difference, with Group S having a higher mean HR than Group I. During the intubation and pin insertion phases, Group S exhibited higher HR values compared to Group I, indicating a potentially more pronounced cardiovascular stimulatory effect of Sevoflurane during these phases. No significant differences in HR were found during the incision phase and at 30 minutes post-operation, suggesting comparable effects of both anesthetic agents. However, at 60 minutes post-operation, Group S showed a significantly higher mean HR than Group I, indicating a potential differential impact on cardiovascular stability during the early postoperative period. These findings align with previous studies reporting a higher HR with Sevoflurane compared to Isoflurane, suggesting a greater sympathomimetic effect of Sevoflurane. [14, 15] The results of the study provides valuable insights into the cardiovascular effects of both the anesthetics in neurosurgical procedures.

In this study, we compared the systolic blood pressure (SBP) between patients in Group S (Sevoflurane) and Group I (Isoflurane) during different phases of the procedure. Our findings revealed significant SBP differences between the two groups, providing insights into the cardiovascular effects of these anesthetic agents during neurosurgical procedures. Baseline SBP levels were similar between the groups, but during the intubation phase, Group S exhibited a significantly lower SBP. However, during pin insertion, incision, and at 30 minutes post-operation, Group S showed consistently higher SBP values compared to Group I, suggesting a more pronounced hypertensive effect of Sevoflurane during these phases. On evaluating the impact of both the agents on SBP, it was evident at various post-operative time intervals that Sevoflurane consistently exhibiting higher SBP values compared to Isoflurane due to increased sympathetic nervous system activity, leading to enhanced catecholamine release and subsequent vasoconstriction. These findings align with previous research, supporting the idea that Sevoflurane may have a greater hypertensive effect due to its sympathomimetic properties. [16, 17]

On comparison of diastolic blood pressure (DBP) measurements between Group S (Sevoflurane) and Group I (Isoflurane) at various time points significant differences were observed, indicating distinctive effects of the two anesthetic agents on DBP during neurosurgical procedures. Baseline DBP did not show a significant difference between the groups, suggesting similar initial diastolic blood pressure levels. However, during the intubation phase, Group S exhibited a significantly higher mean DBP compared to Group I, indicating a potential hypertensive effect associated with Sevoflurane administration. Significant differences in DBP were also observed during pin insertion, incision, and at 30 minutes post-operation, further emphasizing the divergent effects of the anesthetic agents on DBP during these phases. A similar study performed earlier which was conducted on a similar patient population reported comparable results, demonstrating a higher DBP with Sevoflurane compared to Isoflurane during specific surgical procedures. The findings of their study align with our observations and further support the notion that Sevoflurane may possess a greater hypertensive effect on DBP. [18, 19]

The comparison of mean arterial pressure (MAP) measurements between Group S (Sevoflurane) and Group I (Isoflurane) at different time points revealed significant differences, indicating varying effects of the two anesthetic agents on MAP during neurosurgical procedures. Baseline MAP did not show a significant difference between the groups, suggesting comparable initial arterial pressure levels. However, during the intubation phase, Group S exhibited a significantly lower mean MAP compared to Group I, indicating a potential hypotensive effect associated with Sevoflurane administration. Significant differences in MAP were also observed during pin insertion, incision, and at 30 minutes post-operation,

highlighting the distinct hemodynamic responses to the anesthetic agents during these phases. These findings aligns with results of previous study that investigated MAP differences between Sevoflurane and Isoflurane in a similar patient population. [20, 21]

In comparing the emergence time, extubation time, Aldrete Score, Brain Relaxation Score, and adverse events between Sevoflurane and Isoflurane, it was observed that Sevoflurane exhibited significantly shorter emergence and extubation times compared to Isoflurane, indicating a faster recovery and smoother restoration of airway reflexes. Furthermore, Sevoflurane resulted in a shorter time to achieve an Aldrete Score greater than 8, indicating a quicker postoperative recovery. However, there was no significant difference in the Brain Relaxation Score between the two groups, suggesting similar effectiveness in achieving optimal brain relaxation. Both Sevoflurane and Isoflurane exhibited comparable incidences of nausea/vomiting and shivering, indicating similar tolerability. [22, 23, 24]

Conclusion

Present study comparing the effects of Sevoflurane and Isoflurane during neurosurgical procedures revealed significant differences between the two anesthetic agents. Sevoflurane demonstrated faster emergence and extubation times, indicating a quicker recovery and smoother restoration of airway reflexes compared to Isoflurane. Additionally, Sevoflurane resulted in a shorter time to achieve a higher Aldrete Score, indicating a faster postoperative recovery. However, there were no significant differences in the Brain Relaxation Score, suggesting comparable effectiveness in achieving optimal brain relaxation. Both anesthetics exhibited similar incidences of nausea/vomiting and shivering, indicating comparable tolerability. Future studies with larger sample sizes and assessments of long-term outcomes are needed to validate and expand upon these findings and explore the cost-effectiveness of Sevoflurane and Isoflurane in neurosurgical settings. Further, comparative studies involving other volatile anesthetics or alternative anesthetic techniques could offer additional insights into the optimal anesthetic management for neurosurgical procedures.

5. References

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