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Comparison of Recovery Profile of Sevoflurane and Desflurane in Patients Undergoing Elective Neurosurgical Procedures

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Abstract

Aim: The primary objective of the study was to compare the early post-operative recovery profile of Sevoflurane with Desflurane in adult patients undergoing elective neurosurgical procedures, with respect to emergence time, extubation time and the time taken to reach Aldrete score of 9. The secondary objectives were comparison of intra-operative hemodynamics, brain swelling, post-operative nausea and vomiting (PONV) and shivering. *Methodology:* After obtaining Institutional Ethical Committee (IEC) approval, 50 consenting adult patients posted for elective craniotomies were randomly allocated by computer generated random number technique into two groups, Group S (Sevoflurane) and Group D (Desflurane). Patients were preoxygenated and induced as per institution protocol. Patients were intubated with appropriate size endotracheal tube and anaesthesia was maintained with O_2: Air at 50%, chosen volatile anaesthetic that was age adjusted to obtain 1 MAC. Tidal volume and respiratory rate were adjusted to obtain an End tidal CO_2 ($EtCO_2$) of 30-35 mmHg. Normothermia was maintained with forced air warmer. When the duramater was opened, subjective assessment of brain swelling was done by the neurosurgeon, who was blinded to the study group. Infusions were stopped once the bone flap was secured and the volatile agent was discontinued after skin closure and detachment of Mayfield head holder. Patients were reversed and extubated after TOF ratio was > 0.9 and hemodyamics were stable. Intra-operative hemodynamics, brain swelling, emergence time, extubation time, time to reach Aldrete score of 9, PONV and shivering were recorded and patients were shifted to Post-Anaesthesia Care Unit (PACU) for monitoring. *Results:* Statistical analysis was done using SPSS software. Descriptive statistics of mean and standard deviation were arrived for the variables wherever appropriate and Paired 't' test, Chi-square test or Fischer's test were used wherever appropriate to compare the mean difference between the variables to derive the p-value. A p-value of <0.05 was considered statistically significant. The Emergence time (Group S 8.28 ± 3.75 minutes vs. Group D 8.44 ± 3.98 minutes; p-value 0.885), Extubation time (Group S 11.84 ± 4.13 minutes vs. Group D 11.92 ± 5.01 minutes: p-value 0.959), time to reach Aldrete score of 9 (Group S 7.72 ± 4.2 minutes vs. Group D 6.2 ± 3.74 minutes: p-value 0.618) were statistically and clinically comparable. The secondary objectives of the study like intra-operative hemodynamics (MAP with p-value 0.977, HR with p-value 0.431), brain swelling (p-value 1.00), PONV (p-value 0.307) and shivering (p-value 1.00) were also comparable between two groups. *Conclusion:* We conclude that there was no statistically significant difference in early recovery profile between Sevoflurane and Desflurane in neurosurgical procedures with respect to emergence time, extubation time and time to reach Aldrete score of 9. There was no significant difference in intra-operative hemodynamics, incidence of postoperative nausea and vomiting, shivering and brain swelling between both the groups.

Keywords: Desflurane; Sevoflurane; Emergence time; Extubation time.

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Introduction

Inhalational anaesthetics are the most common drugs used for maintaining anaesthesia in Neurosurgery due to ease of administration, end tidal volatile agent monitoring and predictable recovery characteristics. Isoflurane has been the gold standard volatile anaesthetic for neurosurgery [1] because of reduction of cerebral metabolism and intracranial tension. However, recovery from Isoflurane anaesthesia has been slightly prolonged because of its lipid solubility. Remarkable changes in recovery profile of patients undergoing neurosurgery has been noted after the introduction of less soluble volatile anaesthetic agents like Sevoflurane and Desflurane.

Both Sevoflurane (fluorinated methyl isopropyl ether) and Desflurane (fluorinated methyl ethyl ether) are fluorinated inhalational anaesthetic agents characterised by low Blood/Gas partition Coefficient. Though both these agents have favourable recovery characteristics, Desflurane is slightly better due to difference in Blood:Gas partition coefficients (0.42 vs 0.69) [2]. Use of these volatile anaesthetics for providing balanced anaesthesia for neurosurgical procedures results in better haemodynamic stability and faster recovery independent of the duration of administration. Faster recovery from anaesthesia enables earlier neurological assessment and detection of life threatening complications, thereby earlier appropriate interventions. Various studies have been published comparing Sevoflurane with Desflurane in ambulatory surgeries, with Desflurane having better recovery profile. However comparison of Sevoflurane with Desflurane in patients undergoing neurosurgical procedures are rare.

With this background, we devised a prospective, comparative single blinded and randomised study to compare the early recovery profile of Sevoflurane and Desflurane in patients undergoing neurosurgery with respect to Emergence time, Extubation time and Time required to reach modified Aldrete score 3 of 9 (Table 1). Secondary variables include Intra-operative Haemodynamics, Degree of brain swelling and post-operative vomiting and shivering were also noted.

Materials and Methods

After obtaining institutional ethical committee approval and informed consent, 50 adult patients admitted in tertiary care centre, posted for elective craniotomies were randomly allocated into Sevoflurane (S) and Desflurane (D) groups. All consenting patients with ASA Physical status 1 and 2 in age group 18-75 years with GCS 15/15 undergoing elective craniotomy were included in the study. Patient's with haemodynamic instability, GCS <15, patients exposed to General Anaesthesia within 7 days prior to surgery, allergy to volatile anaesthetics were excluded from the study. Patients were randomly allocated into 2 groups, Sevoflurane (S) and Desflurane (D) by computer generated random number technique. After initiating standard monitoring and preoxygenation, patients were induced with Inj. Thiopentone sodium 5mg/kg, Inj. Fentanyl 2 mcg/kg and Inj. Vecuronium 0.1mg/kg intravenously to facilitate intubation. Intravenous lignocaine 1.5 mg/kg was given to patients 90 seconds prior to intubation to blunt intubation response. Patients were intubated orally with flexometallic endotracheal tube as per their age and sex. Patients were ventilated with a mixture of Air:Oxygen (50:50%), with the volatile anaesthetic selected as per randomization using Datex-Ohmeda Avance®- GE Healthcare Anaesthesia Workstation. Tidal volume was set at 8 ml/kg and the respiratory rate was adjusted to an end tidal $EtCO_2$ of 30-35mmHg. $EtCO_2$, Airway pressure, Tidal volume and O_2/Volatile anaesthetic concentration (with Gas Analyser) was continuously monitored throughout surgery. Muscle relaxation was monitored using Organon TOF Watch using Train-of-four mode. Anaesthesia was maintained with intravenous infusion of Inj. Fentanyl at 0.5 mcg/kg/hr, Inj. Vecuronium at 0.02 mg/kg/hr, titrated to TOF count of 0 and with volatile anaesthetic as per study group. Inhalational anaesthetic concentration was age adjusted to obtain 1 MAC. All patients were infiltrated with 0.25% Inj. Bupivacaine at the site of fixation of Mayfield head holder into the patient's head and on the scalp over the surgical field. Arterial Blood Gas analysis was done prior to extubation and 6 hours after extubation. Intra-operatively, normothermia was maintained with forced air warming system and body temperature was monitored with an oesophageal probe. When duramater was opened, the neurosurgeon, who was blinded to the study group assessed the degree of brain swelling on a four point scale.

1. Relaxed brain
2. Mild brain swelling (acceptable)
3. Moderate brain swelling (no treatment required)
4. Severe swelling (treatment required)

At the end of surgery, patients were extubated after TOF ratio was > 0.9, respiratory function was

clinically adequate (tidal volume > 8 ml/kg, SpO_2 >96% with FiO_2 0.4) and hemodynamics was stable. Postoperative pain was managed with Inj.Ketorolac sodium and Intravenous Paracetamol.

The primary objectives of the study were defined as follows:

- Emergence time is time from the cessation of volatile anaesthetic till patient opened the eyes to verbal commands.
- Tracheal extubation time is time from the discontinuation of volatile anaesthetic to extubation.
- Modified Aldrete score: Target score of 9.

The secondary objectives were presence/absence of brain swelling, intra-operative hemodynamics (heart rate, blood pressure), Post-operative nausea and vomiting (which was treated with Inj. Ondansetron 4 mg intravenously) and shivering (which was treated with Inj. Tramadol 1 mg/kg intravenously.

Data Analysis

Descriptive statistics of mean and standard deviation were arrived for the variables: age, HR, MAP, emergence time, extubation time and time to reach Modified Aldrete score of 9, with 95% confidence interval. Paired 't' test, Chi square test and Fischer's test were used, wherever appropriate, to compare the mean difference between the variables to derive the p-value. p value <0.05 was considered as statistically significant. Data entry was done in Microsoft Excel 2007 and analyzed using SPSS version 16.

Results

The mean age in group S was 42.2 ± 15.3 years and 39.6 ± 16.1 years in Group D. The demographic profile showed no significant difference statistically, with the p-value being 0.561 for age and 0.400 for gender distribution between the two groups. The mean Emergence time was 8.28

Table 1: Modified aldrete score

	2	1	0
Respiration	Able to take deep breath and cough	Dyspnea/Shallow breathing	Apnea
Oxygen saturation	Maintains >92% on room air	Needs O_2 inhalation to maintain saturation >90%	Saturation < 90% even with O_2 supplementation
Consciousness	Fully awake	Arousable on calling	Not responding
Circulation	BP+/- 20mmHg preoperative	BP+/-20- 50mmHg preoperative	BP+/- 50mmHg preoperative
Activity	Able to move 4 extremities voluntarily or on command	Able to move 2 extremities voluntarily or on command	Able to move 0 extremities voluntarily or on command

Table 2: Comparison of parameters between Group S and Group D

		Group S (n=25) Mean ± SD	Group D (n=25) Mean ± SD	p-value (<0.05 statistically significant)
Age (in mean years ± SD)		42.2 ± 15.3	39.6 ± 16.1	0.561
Gender (Male/Female)		13/12	16/9	0.400
Mean Heart rate (beats/min)		77.7 ± 13.7	80.9 ± 14.8	0.431
MAP (mmHg)		82.2 ± 11.3	82.3 ± 11.2	0.977
Brain swelling	Yes	6	6	1.0
	No	19	19	
Mean Emergence Time		8.28 ± 3.75	8.44 ± 3.98	0.885
Mean Extubation Time		11.84 ± 4.13	11.92 ± 5.01	0.959
Mean Time to Aldrete score of 9		7.72 ± 4.2	6.2 ± 3.74	0.618
Shivering	Yes	2	2	1.0
	No	23	23	
PONV	Yes	1	3	0.307
	No	24	22	

± 3.75 minutes in Group S compared with 8.44 ± 3.98 minutes in Group D with p-value of 0.885. The mean Extubation time was 11.84 ± 4.13 minutes in group S and 11.92 ± 5.01 minutes in Group D with p-value of 0.959. The mean time to reach Modified Aldrete score of 9 was 7.72 ± 4.2 minutes in group S and 6.20 ± 3.74 minutes in group D (p-value 0.618). The mean emergence time and mean extubation time was shorter in group S compared to group D. However the time to reach Modifed Aldrete score of 9 was shorter in group D than group S. Statistical analysis revealed insignificant difference in early recovery profile between both the groups.

Out of the total 50 patients, 12 patients (6 in each group) had brain swelling. Only 2 patients in group D had moderate brain swelling, the rest had mild swelling. There was no significant difference in brain swelling between the groups. The mean pulse rate was 77.7 ± 13.7 in the group S and 80.9 ± 14.8 per minute in group D (p-value = 0.431). The mean MAP for the two groups S and D was 82.2 ± 11.3 and 82.3 ± 11.2 mmHg, respectively (p-value = 0.977). There was no significant difference in heart rate, mean arterial pressure between both groups. Shivering was observed in 2 patients in each group. PONV was observed in 1 out of 25 and 3 out of 25 in groups S and D respectively. There was no statistically significant difference in the incidence of PONV and shivering between Group S and D.

Discussion

In our study of comparison of recovery profile of Sevoflurane and Desflurane in patients undergoing elective neurosurgical procedures, using balanced anaesthetic technique, we compared the emergence time, extubation time and time to reach Aldrete score of 9. We also compared the intra-operative hemodynamics, degree of brain swelling, PONV and shivering in patients of both groups. Our study revealed clinically and statistically insignificant difference in early post-operative recovery outcome between Sevoflurane and Desflurane groups with respect to emergence time, extubation time and time to reach Aldrete score of 9.

The early post-operative recovery profile in our study was comparable with the study conducted by Halit Cobanoglu *et al.* [3]. Patients anaesthetized with Sevoflurane had shorter extubation time (7.3 ± 1.8 minutes in Sevoflurane group and 7.4 ± 2.4 minutes in Desflurane group), shorter time to eye opening and reached Modified Aldrete score of 9 earlier, than patients in Desflurane group, though without any statistical significance. Our results are also in accordance with the study by Giuseppina Magni *et al.* [2], which was conducted in patients undergoing craniotomy for supratentorial intracranial surgery, with comparable emergence time. However, extubation time was shorter in Desflurane group in their study (11.3 ± 3.9 minutes in Desflurane group versus 15.2 ± 3 minutes in Sevoflurane group). The difference may be attributed to the age adjusted target MAC of 1.2 used in the study compared to target MAC of 1 in our study. In the study done by Ayman A. Ghoneim, *et al.* [4], there was no significant difference in emergence time and extubation time between Sevoflurane and Desflurane. Our results are also similar to the study done by Surya Kumar Dube *et al.* [5], where there was no difference in emergence time (7.4 ± 2.7 minutes in Desflurane group versus 7.8 ± 3.7 minutes in Sevoflurane group, p-value = 0.65) and extubation time (11.8 ± 2.8 minutes versus 12.9 ± 4.9 minutes in Sevoflurane group, p-value = 0.28) in patients anaesthetized with Desflurane or Sevoflurane for neurosurgeries. There are few other studies too, where patients in Desflurane group have significant shorter emergence time and extubation time. However, these studies, to name a few, done by Nathanson *et al.* [7] was in outpatient surgeries, Heavner et al. [8] was in geriatric patients, Dupont *et al.* [9] was in pulmonary surgeries, Michael Tarazi's [10] was in laparoscopic tubal ligation and Kim's [11] was in minor ear, nose, throat surgeries. None of these studies were done in neurosurgeries. Hence, results were not comparable with our study. Prospective studies comparing Sevoflurane and Desflurane in neurosurgeries are very few.

Karamehmet, Yildiz *et al.* [12] compared Desflurane and Isoflurane in terms of hemodynamic stability, brain relaxation and postoperative recovery characteristics, with administration of 1 MAC of the volatile agent in patients undergoing craniotomy for supratentorial lesions and concluded that the Desflurane group had earlier post operative cognitive recovery, however with statistically significant higher intraoperative MAP. Alex Macario, *et al.* [13] did a meta-analysis of trials comparing the recovery profile of Sevoflurane and Desflurane. This study included 22 published reports of 25 studies. The meta-analysis revealed a faster recovery profile of Desflurane compared to Sevoflurane. The results of the metaanalysis was not comparable with our study since it included results from surgeries other than neurosurgery.

In our study, the mean time taken to reach Modified Aldrete score of 9 was shorter in Desflurane group (6.2 ± 3.74 minutes) compared to Sevoflurane group (7.72 ± 4.2 minutes) and was not statistically

significant (p-value 0.618). The study conducted by Ayman A. Ghoneim, *et al.* [4] in 2013 also revealed no significant difference between Sevoflurane and Desflurane in the time interval required to reach Aldrete score of ≥ 9. In the study done by Halit Cobanoglu *et al.* [3] Aldrete scores were compared between Sevoflurane and Desflurane groups, at 2nd minute (9.2 ± 0.4 in Sevoflurane group and 9.3 ± 0.4 in Desflurane group) and 5th minute (10 in both groups) after extubation and was statistically comparable between the two groups.

There was no statistically significant difference in incidence of brain swelling between Sevoflurane and Desflurane groups in our study. But two patients in Desflurane group had moderate brain swelling (which required no active intervention), when compared to none in Sevoflurane group and this can be attributed to the inherent cerebral vasodilating property of Desflurane contributing to a raised ICP. Our results were statistically comparable with the study conducted by Surya Kumar Dube *et al.* [5] with respect to incidence of intra-operative brain condition in Sevoflurane and Desflurane groups. In their study only 2 patients (4%), one in each group required treatment intraoperatively to reduce the brain bulge. Our findings are consistent with that of the study by Todd *et al.* [6] who detected 10% incidence in brain swelling in patients undergoing resection of brain tumours under inhalational anaesthesia. In our study, we did not measure ICP and the assessment of brain swelling was subjectively done by neurosurgeons. But in our study, none of the patients required active intervention to reduce brain swelling.

In our study there was no significant difference in intra-operative hemodynamic parameters between the two groups. Ayman A. Ghoneim, *et al.* [4] detected no difference in hemodynamic parameters including HR and MAP, between Sevoflurane and Desflurane groups. But their study shows significant reduction in MAP after induction in both the groups. Our results were comparable to the study done by Halit Cobanoglu *et al.* [6] where they statistically evaluated the intraoperative hemodynamic parameters, although for first 75 minutes only.

The number of patients involved in the study and allocated to both Sevoflurane and Desflurane groups in our study were comparable with the study conducted by Surya Kumar Dube *et al.* [3] PONV was observed in 4 patients (1 in Sevoflurane and 3 in Desflurane groups, with p-value 0.307) in our study and all the 4 patients were treated with Inj. Ondansetron 4mg i.v 15 patients had PONV (6 in Sevoflurane group and 9 in Desflurane group, with p-value 0.27) in their study. Postoperative shivering was observed in 4 patients (2 in each group) in our study and 2 patients (one in each group) in their study and there was no statistically significant difference. In our study, patients with shivering were treated with Inj. Tramadol 1mg/kg i.v. In the study done by Ayman A. Ghoneim, *et al.* [4], 10% of the patients in Sevoflurane group and 5% in Desflurane group had postoperative vomiting that required treatment with Inj. Ondansetron. In the same study, 20% of patients in the Sevoflurane group and 10% in Desflurane group required treatment with Inj. Nalbuphine for shivering.

Limitations of our study

Our study was designed to detect the early post-operative recovery profile after Sevoflurane or Desflurane administration in balanced anaesthetic technique. However, volatile anaesthetic agents have been shown to affect late cognitive function in adult patients, which was not assessed in our study.

Conclusion

In our study of comparison of recovery profile of Sevoflurane and Desflurane in patients undergoing elective neurosurgical procedures, patients anaesthetised with Sevoflurane had shorter emergence and extubation time compared to Desflurane, though not statistically significant. Patients anaesthetised with Desflurane had shorter time to reach Aldrete score of 9 compared to Sevoflurane, although not statistically significant. There was no significant difference in the other parameters like intra-operative hemodynamics, brain swelling, PONV and shivering. We conclude that both Sevoflurane and Desflurane provide comparable recovery profile in a balanced anaesthesia setting in neurosurgical procedures.

Key Message

There is no statistically significant difference in early recovery profile between Sevoflurane and Desflurane in neurosurgical procedures with respect to emergence time, extubation time and time to reach Aldrete score of 9. There is no significant difference in intra-operative hemodynamics, incidence of postoperative nausea and vomiting, shivering and brain swelling between both the groups.

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