Original article:

Comparison of emergence characteristics of sevoflurane and desflurane in adult patients

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ABSTRACT

BACKGROUND: The aim of the study is to compare and analyse the emergence characteristics of sevoflurane and desflurane in longer duration surgeries (lasting ≥ 2 hours).

METHODS: 92 patients of age 18-60 years belonging to ASA I & II undergoing general anesthesia were randomly allocated into the two groups, to receive either sevoflurane (N=46) or desflurane (N=46) during the maintenance period. Assessment include eye opening, time to extubation, responding to commands and orientation after discontinuing the agent. Intermediate recovery was assessed by using modified Aldrete score. The cognitive function assessed by mini mental score examination preoperatively and at 1, 3 and 6 hours postoperatively.

RESULTS: The emergence time from the end of anesthesia to eye opening, tracheal extubation, following verbal commands, and orientation were significantly shorter in the Desflurane (versus Sevoflurane) Group (P< 0.001) consistent with the previous studies. 60% in the desflurane group and 50% in the sevoflurane group experienced cognitive dysfunction at the end of 1 hour, it persisted in 16% and 13% of the respective group by the end of three hours. However 98% of the patients in the study reached almost baseline MMSE scores by the end of 6 hours.

CONCLUSION: Recovery indices like time to eye opening, time until extubation, time taken to follow commands and time to orientation were significantly better in the desflurane group. Intermediate recovery and side effects were not significantly different in both groups. Postoperative recovery of cognitive function was similar with both volatile anesthetics.

KEY WORDS: Desflurane; Emergence; Sevoflurane

INTRODUCTION

One of the major factors that determine the speed of recovery from anaesthesia is the choice of anaesthetic technique. An ideal general anaesthetic should provide smooth and rapid induction, optimal operating conditions, and rapid recovery with minimal side effects like nausea, vomiting, cognitive dysfunction and postoperative pain.[1]

Inhaled anaesthetics allow rapid emergence from anaesthesia because of easy titrability. Sevoflurane and desflurane both are halogenated ethers, they have rapid induction and recovery due to low blood: gas partition coefficient and fat: blood solubility. Given these features of sevoflurane and desflurane, faster emergence from anesthesia is expected compared to traditional inhalational agents. Because of its pharmacological properties, desflurane appears to yield a rapid, early and intermediate recovery compared to sevoflurane.

However, the results of different studies have been conflicting. Also, desflurane has only recently become available in India and has yet to be studied for longer duration surgeries in Indian population. The purpose of this randomized study is to assess

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the emergence characteristics of sevoflurane and desflurane in surgical procedures lasting more than 2 hours in adult patients.

METHODS

92 patients belonging to ASA grade I or II, with age between 18 to 60 years were recruited for this randomized study. Hospital ethics committee approval and a written informed consent from all the patients were taken. The patients posted for surgical procedures under general anesthesia which would likely to last more than 2 hours were randomized into two groups to receive either sevoflurane (Group S: n = 46) or desflurane (Group D: n = 46) for maintenance of anaesthesia. Patients were excluded for clinically significant neurological, respiratory, cardiovascular, renal, hepatic, psychiatric or history of drug abuse. Patients were also excluded if they are pregnant, undergone recent anaesthesia (within 7 days) or morbid obesity

Detailed history, general physical examination, systemic examination and routine investigations done prior to the day of surgery. Patients premedicated with Tab. Ranitidine 150mg, Tab. Metoclopramide 10mg, and Tab.Alprazolam 0.25mg previous night of surgery orally. Patients kept nil per oral for 8 hours prior to surgery. In the preoperative holding area, the Mini-Mental State Examination (MMSE) test conducted and scores were noted.

After patient shifted to operation room, large bore IV line secured in the non-dominant hand. Standard monitoring ECG, NIBP, SpO2 and Et Co_2 monitors connected and recorded. Premedicated with Ondensetron hydrochloride 4mg, Glycopyrrolate 0.2mg and Standard dose of Fentanyl 1-2mcg/kg IV given and preoxygenated with 100% O_2 for three minutes. Induced with Propofol 2mg /kg IV, Non depolarizing Muscle relaxant Vecuronium bromide (0.1 mg /Kg) administered, airway secured with appropriate size endotracheal tube.

Group S patients maintained with N_2O in O_2 + Sevoflurane (1-2%) + 0.01 mg/Kg of Vecuronium bromide as intermittent doses. Group D patients maintained with N_2O in O_2 + Desflurane (3-6%) + 0.01 mg/Kg of Vecuronium bromide as intermittent doses. Inhalation agents (Sevoflurane / Desflurane) discontinued at the end of procedure and N_2O is discontinued after the last skin suture is placed in both the groups. Reversed with Neostigmine bromide 0.05 mg/kg and Glycopyrrolate 0.008 mg/kg.

The time taken for opening of the eyes and respond to commands is noted. Patients in both the groups extubated once they are Awake, Active, Hemodynamically stable, Breathing adequately. Patient's activity level, Hemodynamic stability, Oxygen saturation status by Pulse Oximeter, Circulation status, Consciousness are assessed by using the Modified Aldrete Scoring System. Scores from the discontinuation of inhalational anaesthetics recorded at 1min interval till 5min arrival in the PACU (Post Anaesthesia Care Unit) and subsequently 5min intervals until the patient achieves the score of 10 and considered fit to be shifted to the ward if they achieve a score of 10. At 1, 3, 6 hours after the end of anesthesia, the patient's cognitive functions assessed by asking them to repeat the Mini mental state examination (MMSE) test. Patients were observed for nausea / vomiting, drowsiness, respiratory distress, delirium, CNS disturbances and pain post operatively and treated accordingly.

STATISTICAL ANALYSIS

Student's *t*-test was performed for continuous variables, and paired Student's *t*-test was used to compare the intragroup differences in the MMSE scores at different assessment points with their baseline values. Categorical data were analyzed by

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chi square test. A value of $P < 0.05$ was considered statistically significant. Data are presented as mean values, numbers or percentages.

Results

The study comprises of 92 patients (46 patients in each group) (39 men, 53 women; mean [SD] age, 40.5 [9.7] years; range, 18-60 years). The two groups were comparable in age, sex distribution, ASA status and body weight. The duration of surgery and side effects were also similar in these two groups.

Time to eye opening, tracheal extubation, responding to commands, orientation, modified Aldrete scoring (MAS) and mini mental state examination (MMSE) were significantly shorter in the desflurane group than in the sevoflurane group ($p < 0.001$).

Figure: 1 Comparison of duration of surgery between two treatment groups

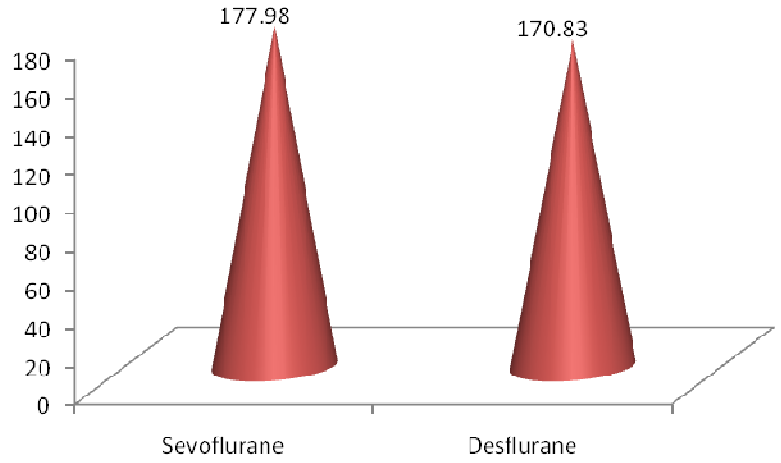

Figure: 2 Comparison of side effects between two treatment groups

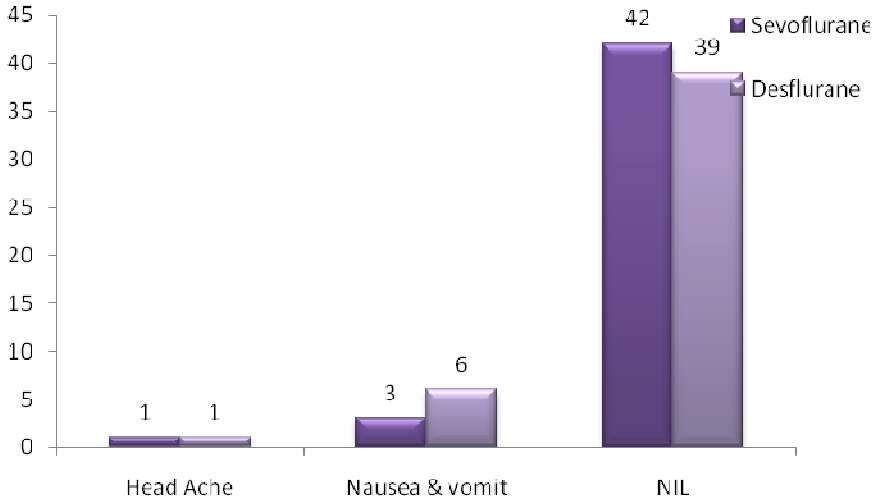

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Figure: 3 Comparison of Recovery Indices between two treatment groups

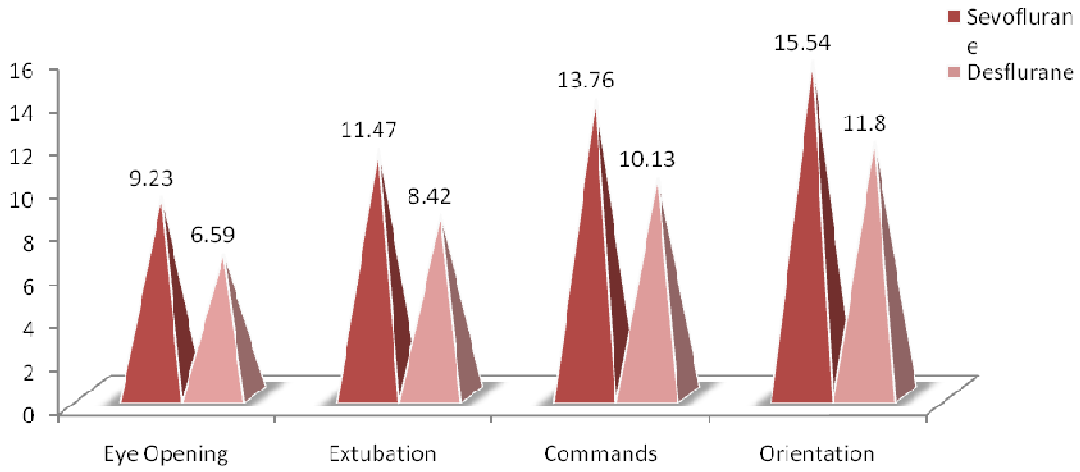

Figure: 4 Comparison of modified Aldrete score in two groups

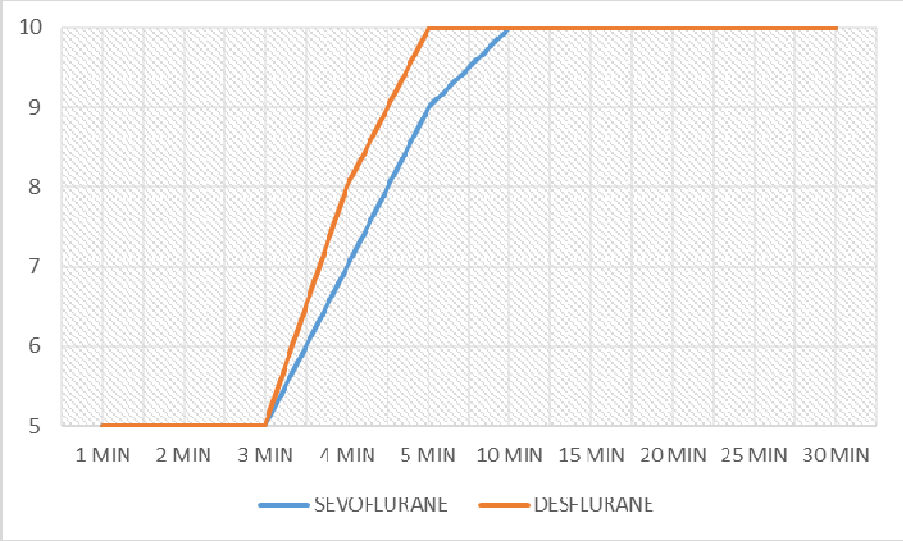

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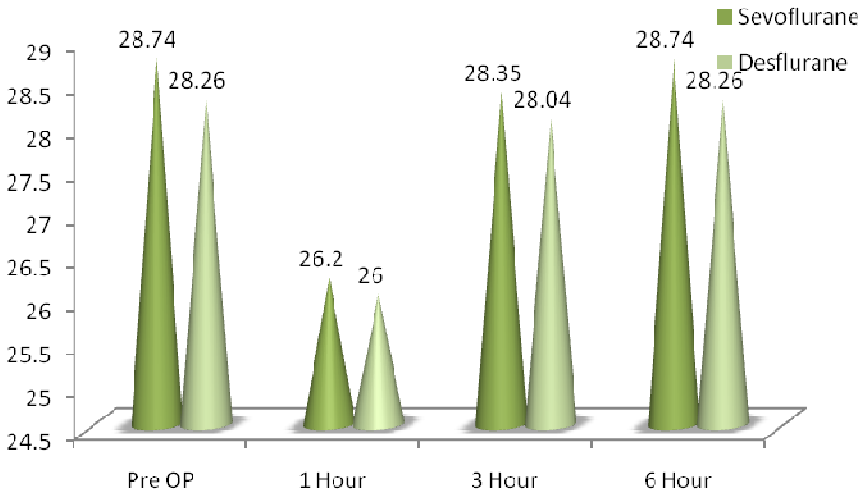
Figure: 5 Comparison Mean values of MMSE Scores over time between two treatment groups



The mean values of pre op MMSE for group Sevoflurane was 28.74 ± 0.98 and group Desflurane was 28.26 ± 0.68, they were statistically significant by student t test (p = 0.01). The mean values of 1 hour post op MMSE for group Sevoflurane was 26.2 ± 0.5 and group Desflurane was 26, they were statistically significant by t test (p = 0.01).

The mean values of 3 hour post op MMSE for group Sevoflurane was 28.35 ± 0.77 and group Desflurane was 28.04 ± 0.3, they were statistically significant by student t test (p = 0.01). The mean values of 6 hour post op MMSE for group Sevoflurane was 28.74 ± 0.98 and group Desflurane was 28.26 ± 0.68, they were statistically significant by t test (p = 0.01) (figure: 5)

DISCUSSION

Recovery is a continual ongoing process and is divided into three phases: early recovery, as the patient emerges from anesthesia and regains vital reflexes; intermediate recovery, when the patient achieves criteria for discharging from the PACU; and late recovery, when the patient returns to his or her preoperative physiological state.[2] Early complete recovery after general anesthesia is desirable in all patients. All volatile agents accumulate, over time, in adipose tissue. Such accumulation may delay recovery from anesthesia.

The pharmacokinetic properties of desflurane and sevoflurane favor better intraoperative control of anesthesia and rapid postoperative recovery. They have significantly lower blood/gas partition coefficient (0.45 and 0.65). The lower fat/blood partition coefficient of desflurane 27, vs 48 for sevoflurane, should favor its early elimination from the body resulting in early recovery.[3] A study comparing recovery characteristics of desflurane and sevoflurane in healthy male volunteers of normal weight, and observed earlier recovery after desflurane anesthesia. They postulated that delayed recovery after sevoflurane could also be attributed to additional factors such as effects of its degradation products after prolonged anesthesia.

The two anesthetic groups were also comparable with respect to demographic variables like, gender, ASA grade, durations of anesthesia and surgery, BMI as well as doses of medications used for

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premedication, propofol induction dose, intra op analgesic requirement. In addition, there were no significant differences in the amounts of postoperative analgesic and the incidence of side effects in the two study groups.

The emergence times from the end of anesthesia to eye opening, tracheal extubation, following verbal commands, and orientation were significantly shorter in the Desflurane vs Sevoflurane Group ($P < 0.001$) consistent with previous studies .The mean time to eye opening were (6.59 min vs 9.23 min) tracheal extubation (8.42 min vs 11.47 min) time to respond to verbal commands (10.13 min vs 13.76 min) and time to orientation (11.8 min vs 15.54 min) for desflurane and sevoflurane in our study.

Faster emergence, extubation with secure airway and maintenance of spontaneous ventilation facilitates recovery, provide better patient comfort, allow a more rapid return to baseline cardiovascular function and permit earlier departure from the operation theater. In our study, early recovery was assessed by response to verbal commands and spontaneous eye opening. Intermediate recovery was assessed using Modified Aldrete score.

In a study comparing desflurane and sevoflurane for the maintenance of anesthesia, Nathanson et al [4] Observed earlier eye opening and decreased time to tracheal extubation with the use of desflurane compared with sevoflurane. Analogues to the findings in this earlier study, the late recovery profiles and incidences of postoperative side effects were similar after desflurane and sevoflurane

As a result of the lower solubility of desflurane (versus sevoflurane) in blood and lean tissues, one might expect to find differences in the intermediate and late recovery end points when these two anesthetics are used for longer surgical procedures. Eger [3] in a study found that for a given duration of anesthesia, elimination was faster and recovery was quicker for desflurane. Other studies [5-8]have found that only early recovery was faster with desflurane compared to sevoflurane even when the duration of surgery exceeds 2 hours. Furthermore, the recovery of psychomotor and cognitive function after desflurane and sevoflurane administration were similar after the first 30-45 min in both younger patients undergoing ambulatory surgery and elderly patients undergoing more prolonged general anesthesia for inpatient procedures.

Gergin [9] studied the hemodynamics, emergence and recovery characteristics of sevoflurane with those of desflurane in nitrous oxide anesthesia and concluded that the groups did not differ in these hemodynamic measures. However, a study by Elbert [10] concluded that neurocirculatory excitation seen with rapid increase in desflurane did not occur with sevoflurane. At steady state, increasing the concentration of sevoflurane was associated with lower sympathetic nerve activity and central venous pressure.

The incidence of other postoperative complications (postoperative nausea and vomiting, headache, drowsiness) was also similar in both groups. This was in contrast with to a study by karlsen [11]who found that the postoperative nausea/vomiting rate was higher in the desflurane group (67%) than that in sevoflurane group (36%).

Ravi Jindal [1] studied the comparison of maintenance and emergence characteristics after desflurane or sevoflurane in outpatient anaesthesia and concluded that both desflurane and sevoflurane groups had rapid recovery. There was a significant difference in the emergence and early recovery between two groups. The early recovery was faster with desflurane compared to sevoflurane. Although there was difference in intermediate recovery time,

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the magnitude of the difference was small and insignificant.

In a study conducted by Amandeep Kaur [12] on hemodynamic and early recovery characteristics of desflurane versus sevoflurane in bariatric surgery, concluded that early postoperative recovery was significantly rapid after desflurane anesthesia and patients could be transferred to PACU earlier. The intermediate recovery as evaluated by Modified Aldrete score at 5 minutes and the DSST also occurred earlier in the desflurane group.

Because a depth of anesthesia monitor was not available to ensure that patients were being maintained at comparable levels of anesthesia during the maintenance period, the anesthesia providers were forced to rely on clinical signs (i.e, maintenance of hemodynamic stability). This study can be criticized because the protocol design did not permit a double blind comparison of the maintenance anesthetic technique. In addition to this, we were not able to blind the anesthetist to the anesthetic because different vaporizers were used to administer the two anesthetics. Another criticism of this study design relates to a lack of investigator blinding in the assessments of early recovery status. However, investigator bias was minimized by only using objective end points and by blinding the recovery room nursing staff.

The choice of anesthetic drugs can also affect postoperative cognition because residual levels of volatile anesthetics can produce changes in central nervous system activity. [13, 14] Use of anesthetics with a rapid clearance and negligible metabolism may offer advantages in the patients. The volatile anesthetics desflurane and sevoflurane possess low blood-gas partition coefficients, contributing to a faster early recovery from anesthesia compared with the traditional volatile anesthetics. [15, 16]

The MMSE has high specificity for detecting mild cognitive impairment, and thus was chosen for use in our study setting. We are not able to demonstrate a clinically significant difference in MMSE one hour after anesthesia end in patients given sevoflurane and desflurane. Despite the slightly greater likelihood of MMSE decrease one hour after anesthesia in sevoflurane, we were not able to show an intergroup difference of at least 2 points. The small decrease found at one hour was no longer present and MMSE had returned to baseline by 6 hours after anesthesia. Thus our results show only a minimal transient decrease in cognitive function assessed by MMSE one hour after anesthesia with no clinically significant difference between sevoflurane and desflurane when administered as in this setting.

Minhthy Meineke [17] studied cognitive dysfunction following desflurane versus sevoflurane general anesthesia in elderly patients concluded that they not able to demonstrate a clinically significant (at least 2 points) difference in MMSE one hour after anesthesia end, which is titrated to moderate general anesthesia guided by processed EEG. The small decrease found at one hour was no longer present and MMSE had returned to baseline by 6 hours after anesthesia.

CONCLUSION

In our study we found desflurane was associated with a faster early recovery than sevoflurane in patients undergone longer duration surgeries. Recovery indices like times to eye opening, time until extubation, time taken to follow commands and time to orientation were significantly better in the desflurane group. Intermediate recovery and side effects were not significantly different in both groups.

Postoperative recovery of cognitive function was similar with both volatile anesthetics. Most importantly, use of either desflurane or sevoflurane for maintenance of anesthesia was associated with only transient cognitive impairment as assessed by

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MMSE at 1 hour, with 98% of them returning back to their baseline cognitive status 6 hours postoperatively.

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