A Prospective Randomized Study on Intraoperative Haemodynamic and Post-Operative Recovery Characteristics of Sevoflurane and Desflurane in Thyroid Surgeries under General Anaesthesia in Wayanad District

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ABSTRACT

BACKGROUND

Maintaining deep plane of anaesthesia to prevent haemodynamic fluctuation and absolute immobility at the same time ensuring early and smooth recovery to prevent bleeding and assessing vocal cord status are the challenges to the anaesthesiologists in thyroid surgeries. Use of volatile anaesthetics with low solubility and low blood gas partition coefficient are used for their haemodynamic stability and faster emergence from anaesthesia in various surgeries under general anaesthesia. we wanted to compare sevoflurane and desflurane in terms of intraoperative haemodynamics, postoperative emergence and recovery characteristics in thyroid surgeries of less than 2 hours duration.

METHODS

After getting institutional ethical committee approval, 70 patients belonging to American Society of Anaesthesiologists (ASA), physical status I or II undergoing elective thyroid surgery were randomly assigned to two groups to receive either 6 % Desflurane (group D) or 2 % Sevoflurane (group S) for maintenance of general anaesthesia along with 33 % oxygen with 67 % nitrous oxide. The intraoperative heart rate, mean arterial pressure were recorded at 5 minute intervals and recovery characteristics including times to extubation, first spontaneous motion, response to painful pinch, recall of name, hand grip and PARS score ≥ 9 were recorded in both groups.

RESULTS

There was no statistically significant difference ($P > 0.05$) in mean heart rate and mean arterial pressure between group D and S and remained within 20 % of baseline. The time to achieve a PARS ≥ 9 was earlier in the desflurane group and it was statistically significant.

CONCLUSIONS

Desflurane and Sevoflurane based anaesthesia provides comparable intraoperative haemodynamics whereas post-operative recovery was quicker in patients who received Desflurane compared to Sevoflurane.

KEYWORDS

Desflurane, Haemodynamics, Recovery, Sevoflurane

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DOI: 10.18410/jebmh/2021/384

How to Cite This Article:
Siddique FK, Aravind A, Mansoortheen A. A prospective randomized study on intraoperative haemodynamic and postoperative recovery characteristics of sevoflurane and desflurane in thyroid surgeries under general anaesthesia in Wayanad district. J Evid Based Med Healthc 2021;8(24):2045-2051. DOI: 10.18410/jebmh/2021/384

Submission 15-02-2021,
Peer Review 23-02-2021,
Acceptance 29-04-2021,
Published 14-06-2021.

BACKGROUND

Thyroidectomy is one of the most common surgical treatment procedures done for various disease conditions of thyroid throughout the world. The deranged endocrine homeostasis that might be unrecognized, especially while handling the thyroid gland during surgery can produce sympathetic stimulation leading to haemodynamic instability. As the thyroid gland is being surrounded by vital vascular and neural structures and thyroidectomy being a microscopic surgery, absolute immobility is mandatory during the surgical procedure. Surgical opening of neck veins during thyroidectomy may lead to venous air embolism and spontaneous breathing during surgery increases the risk of the same. Bucking and coughing during extubation may cause bleeding from the surgical site leading to thyroid hematoma which in turn can compromise the airway and even endanger the life of the patient. As vocal cord palsies are one of the immediate post-operative complications following thyroid surgeries, early assessment of vocal cord is essential soon after extubation. So, maintenance of deep plane of anaesthesia with stable haemodynamic and providing absolute immobility at the same time ensures early smooth recovery to prevent bleeding and assessing of vocal cord are the challenges to the anaesthesiologists during thyroid surgeries.[1]

Volatile anaesthetic agents with low lipid solubility and blood gas partition coefficient are known to produce deep plane of anaesthesia with haemodynamic stability, augmenting muscle relaxation and produces early recovery from anaesthesia.[2,3] Desflurane and sevoflurane having these properties are used for maintenance of general anaesthesia during various surgeries including thyroidectomy. These agents are popular for their use in day-care surgeries and patients with compromised cardiovascular reserve. Sevoflurane is less airway irritant, having more bronchodilation and lesser incidence of post-operative nausea and vomiting than desflurane. Change over from high flow to low flow is faster with desflurane and risk of hypoxia is less with desflurane compared to sevoflurane. Early recovery will also help in better post-operative outcome and early discharge from hospital thus reducing overall coast of treatment.

There is a paucity of literature comparing haemodynamic and recovery characteristics of these inhalational anaesthetic agents in thyroid surgeries. Hence, we decided to conduct a study to compare the intraoperative haemodynamic and recovery characteristics of desflurane and sevoflurane in patients undergoing elective thyroid surgeries under general anaesthesia.

Aims and Objectives

The aim of this study was to compare the intra-operative haemodynamic, post-operative emergence and recovery characteristics of sevoflurane and desflurane in elective thyroid surgeries of less than 2 hours duration. The hypothesis of this study was that there is no difference in intra-operative haemodynamic and post-operative emergence characteristics between desflurane and sevoflurane.

The objectives of the study were

1. To compare the haemodynamic characteristics of sevoflurane and desflurane based anaesthesia with respect to mean arterial pressure and mean heart rate.
2. To find out percentage variation of mean arterial pressure and heart rate from baseline in sevoflurane and desflurane based anaesthesia.
3. To compare the recovery characteristics of sevoflurane and desflurane with respect to time taken for tracheal extubation, first spontaneous motion, response to painful pinch, recall of name, handgrip and time to achievement of PARS score (Post Anaesthetic Recovery Score of Aldrete and Kroulik)of ≥ 9.

METHODS

It is a prospective randomised study done in a 700 bedded tertiary care centre on 70 patients aged between 18 - 60 years, belonging to American Society of Anaesthesiologists physical status (ASA-PS) I or II, posted for elective thyroidectomy under general anaesthesia for a period of one year from August 2019 to July 2020. After getting approval from institutional ethics committee (IEC) and informed written consent for voluntary participation in the study, patients were randomly divided into two groups to use either Desflurane (Group D) or Sevoflurane (Group S) for maintenance of general anaesthesia.

To get 95 % confidence interval and 80% power sample size (N) was calculated using the formula:

$$N = \{2 \times (Z\alpha + Z\beta)^2 \times SD2\} / D^2$$

Where Zα = significance level = 1.96, Zβ = power = 0.84, D = clinically relevant effect size. In the study conducted by Jindal R et al.[3] to compare the maintenance and emergence characteristic of sevoflurane and desflurane the time to achieve a PARS score of 9 were 16.20 (± 3.870) and 10.80 (± 3.774) minutes respectively. So, using the above formula to get 95 % confidence interval and 80 % power compared to this study and considering the clinically significant effect size to be at least 2 minutes about 29 subjects were needed in each group. So, we included 35 subjects in each group and a total of 70 subjects were recruited.

Those patients with history of psychiatric disorder, chronic alcoholism, recent exposure to GA within 7 days of surgery, patients on long term opioids or sedative medication, those allergic to study drugs, potential susceptibility to malignant hyperthermia, pregnant patients or surgery lasting more than 2 hours were excluded from the study. A detailed pre-operative clinical evaluation to assess the associated co morbid illnesses, previous anaesthetic exposures, vocal cord assessment and airway assessment done well before the planned date of surgery. Baseline blood investigations like blood grouping, complete haemogram,

renal function tests, serum electrolytes and thyroid function tests were performed along with required radiological investigations and 12 lead electrocardiogram (ECG). Patients were advised to follow fasting guidelines and aspiration prophylaxis and anti-anxiety drugs were given on the night prior to surgery. One unit of cross matched blood was arranged for all patients before surgery.

On arrival to the pre-operative room, informed written consent was obtained. Post anaesthetic recovery score of Aldrete and Kroulik and methods of recovery assessment were explained to the patients. In operation theatre, standard monitors, neuromuscular monitor, Bispectral index monitor and gas monitors were connected. Standard monitoring included electrocardiogram, pulse oximetry, non invasive blood pressure, end tidal carbon dioxide and temperature. Baseline heart rate (HR), mean arterial pressure (MAP), oxygen saturation were recorded before start of anaesthesia. An 18 G intravenous cannula was secured in upper limb and started on balanced salt solution infusion.

After preoxygenation with 100 % oxygen for 3 minutes, patients were premedicated with midazolam 0.05 mg/kg and glycopyrrolate 10 µg/kg intravenously (IV). General anaesthesia was induced with fentanyl 2 µg/kg and propofol 2 mg/kg IV, and intubation was facilitated with vecuronium 0.1 mg/kg IV. Patients were intubated with appropriate size endotracheal tube by video laryngoscopy. General anaesthesia was maintained with 33 % oxygen with 67 % nitrous oxide and desflurane (Group D) or sevoflurane (Group S) to maintain a minimum alveolar concentration (MAC) of 1.3. Ventilation was controlled to maintain end-tidal carbon dioxide between 32 and 36 mmHg. Fentanyl 1 µg/kg IV was repeated after 1 hour. Vecuronium 0.02 mg/kg intravenously was repeated as per neuromuscular monitoring. MAP and HR were recorded before start of anaesthesia and every 5 minutes after induction of general anaesthesia, after intubation and after extubation.

The maintenance dose of anaesthetics was adjusted to maintain a Bispectral Index of 40 - 60. Increase or decrease in MAP and/or heart rate by 20 % from preinduction values was treated with injection Fentanyl 1 ug/kg or intravenous fluids respectively. And if the MAP and HR are not responding to the above treatments, the patient is excluded from the study and haemodynamics are managed accordingly. Volatile anaesthetic was stopped after closure of skin.

After stoppage of the volatile agent, another anaesthesiologist was posted for tracheal extubation and for assessing the recovery characteristics of the patient from general anaesthesia. Neuromuscular blockade was reversed with inj. neostigmine 40 µg/kg IV and inj. glycopyrrolate 10 µg/kg IV. When patient shows regular spontaneous breathing pattern and is able to open their eyes on command with TOF count being 4, tracheal extubation was done. The time of discontinuation of anaesthetic agents was taken as time zero. Recovery time was noted at 1 - minute intervals to awakening. Time to tracheal extubation, first spontaneous motion, response to painful pinch, recall of name, handgrip and time to achieve a PARS score ≥ 9 were recorded.

Statistical Analysis

Statistical analysis was done using statistical package for social sciences (SPSS) package (version 17, SPSS Inc, Chicago, USA) software for Windows. Qualitative data were expressed as percentages and proportions. Quantitative data were expressed as mean and standard deviation. Qualitative data was compared using chi square test and quantitative data compared using independent T test. A P value of less than 0.05 was taken as significant.

RESULTS

Before analysis to know whether the groups were comparable, demographic variables, baseline heart rate and mean arterial pressures were compared. Total of 70 patients were enrolled in the study and all participants completed the study without any dropouts or exclusion (figure 1).

There was no statistically significant difference in demographic variables like ASA PS, weight, age, gender and duration of surgery between group D and group S (Table 1). The pre-operative (baseline) mean HR and MAP were 82.57 ± 6.12 sec, 90.14 ± 6.92 mmHg and 91.91 ± 6.25 mmHg, 83.83 ± 7.82 mmHg in Group D and Group S respectively, and there was no statistically significant difference between these variables (P - value > 0.05).

Mean HR and MAP at every 5 min interval were compared between two groups and was found to be statistically insignificant (all P - values > 0.05) (Table 2). Percentage variation of HR and MAP were within 20 percentage of baseline in each group. There was no statistically significant percentage variation of HR and MAP at induction, 5 minutes post intubation, 10 minutes post intubation and after extubation between both groups (Figure 2).

Patient moved their limbs in a mean time of 3.97 $\pm$ 0.71 minutes in desflurane group compared to 7.17 $\pm$ 0.79 minutes in the sevoflurane group after discontinuation of anaesthetic. Response to pain was achieved in a mean time of 5.4 $\pm$ 0.88 minutes and 8.57 $\pm$ 0.92 minutes in group D and group S respectively. The patients in group D were extubated earlier than those in the group S. The patients in group D recalled their names in a mean time of 7.91 ± 0.82 minutes compared to 12.37 ± 1.19 minutes in group S. Hand grip was achieved earlier in the group D (9.31 ± 0.87 minutes) compared to 14.23 ± 1.29 minutes in sevoflurane group. The post anaesthesia recovery score of greater than 9 (PARS ≥ 9) was achieved in a mean time of 10.51 $\pm$ 0.89 minutes in group D which was faster than sevoflurane group (16.69 ± 1.47 minutes). All these differences were statistically significant with a P value of less than 0.05 (Figure 3).

Demographic Parameter		Group D	Group S
ASA PS	I	22	18
	II	13	17
Sex	Male	12	12
	Female	23	23
Weight (Kg)		60.14 ± 4.70	61.60 ± 5.05
Duration of surgery (minutes)		106.60 ± 6.44	103.94 ± 5.14
Age (years)		38.91 $\pm$ 10.72	40.09 $\pm$ 10.23

Table 1. Comparison of Demographic Parameters (Group D-Desflurane Group, Group S-Sevoflurane Group)

Time (In Minutes)	Heart Rate			Mean Arterial Pressure		
	Group-D (Mean ± SD)	Group-S (Mean ± SD)	P value	Group-D (Mean ± SD)	Group-S (Mean ± SD)	P Value
Baseline	82.57 ± 6.12	83.83 ± 7.82	0.46	90.14 ± 6.92	91.91 ± 6.25	0.27
Induction	75.31 ± 7.14	75.11 ± 7.44	0.91	81.49 ± 8.22	82.49 ± 7.80	0.60
5 (post-intubation)	82.00 ± 6.97	82.37 ± 8.04	0.84	85.83 ± 8.13	87.23 ± 8.49	0.48
10	80.06 ± 6.83	79.60 ± 8.96	0.81	83.94 ± 7.44	85.29 ± 7.72	0.46
15	78.97 ± 6.88	78.11 ± 8.74	0.65	83.06 ± 7.29	83.71 ± 7.80	0.72
20	77.11 ± 5.75	77.43 ± 8.41	0.86	82.89 ± 7.14	82.74 ± 7.70	0.94
25	76.54 ± 5.52	76.71 ± 8.37	0.92	82.51 ± 7.01	82.51 ± 7.44	1.00
30	76.66 ± 5.26	76.00 ± 8.88	0.71	82.23 ± 6.91	82.17 ± 7.10	0.97*
45	75.80 ± 5.78	74.66 ± 8.40	0.51	82.17 ± 7.11	81.29 ± 6.60	0.59
60	77.63 ± 7.23	76.94 ± 8.83	0.72	81.74 ± 6.84	82.14 ± 6.36	0.80
75	75.97 ± 6.32	74.49 ± 7.15	0.36	82.09 ± 6.48	81.83 ± 6.05	0.86
90	77.60 ± 7.47	76.03 ± 7.02	0.37	82.91 ± 5.85	82.74 ± 5.59	0.90
105	84.03 ± 7.42	80.89 ± 7.49	0.08	87.57 ± 6.94	85.71 ± 6.28	0.25
110	85.30 ± 8.32	85.26 ± 7.85	0.98	88.04 ± 7.53	89.06 ± 6.95	0.61
115	87.94 ± 6.03	89.10 ± 7.26	0.61	91.75 ± 7.13	94.00 ± 7.69	0.37
120	93.83 ± 4.97	95.43 ± 6.90	0.51	97.92 ± 5.44	98.69 ± 3.12	0.66

Table 2. Comparison of Haemodynamic Parameters. (Group D-Desflurane Group, Group S-Sevoflurane Group)

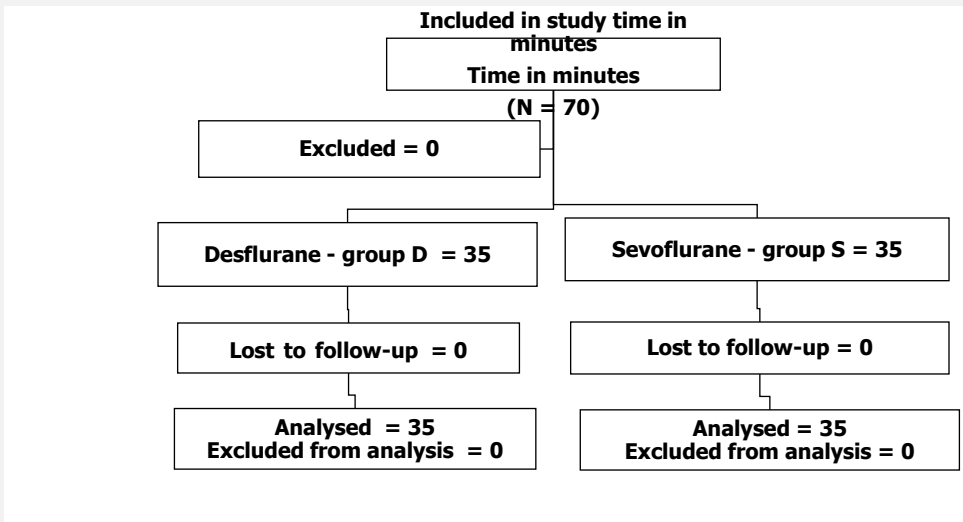

Figure 1. Consort Flow Chart

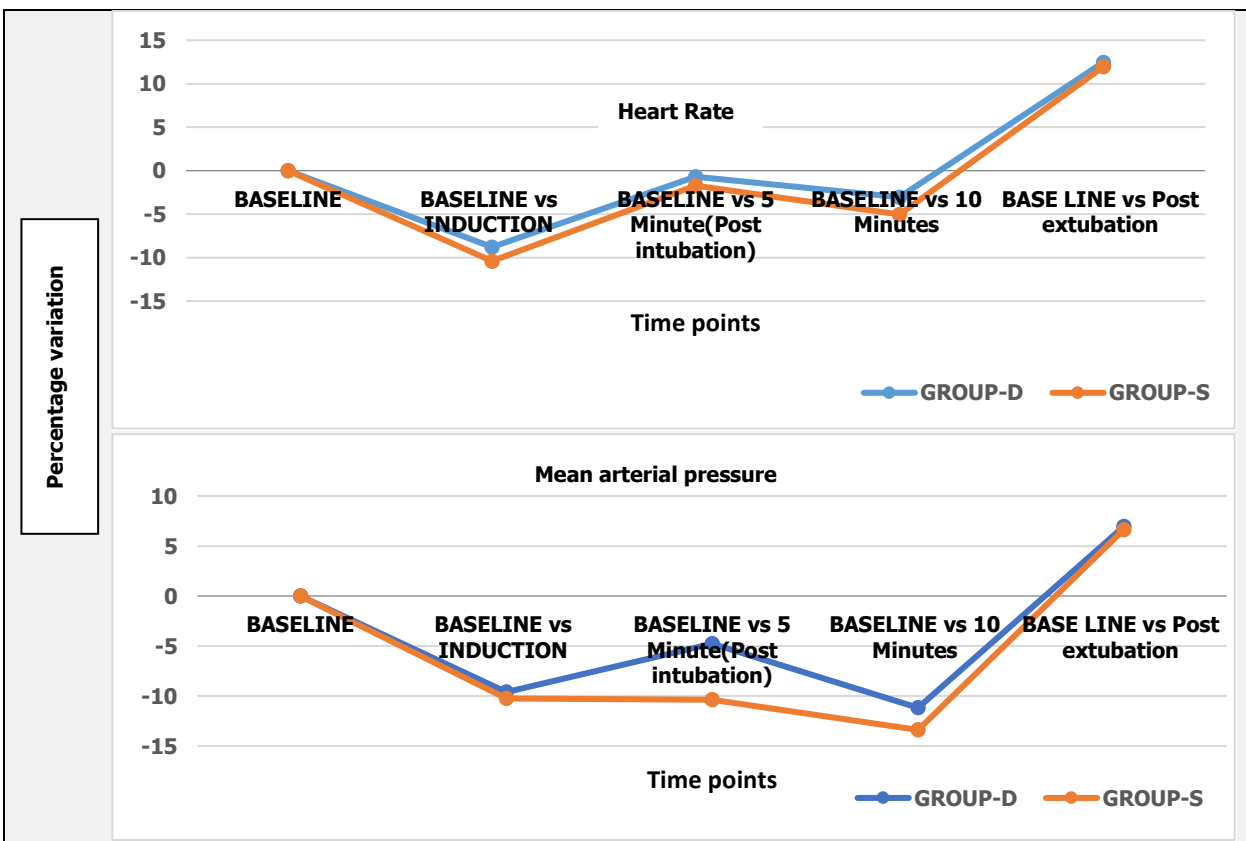

Figure 2. Comparison of Percent Variation of Heart Rate and Mean Arterial Pressure (Group D - Desflurane Group, Group S - Sevoflurane Group)

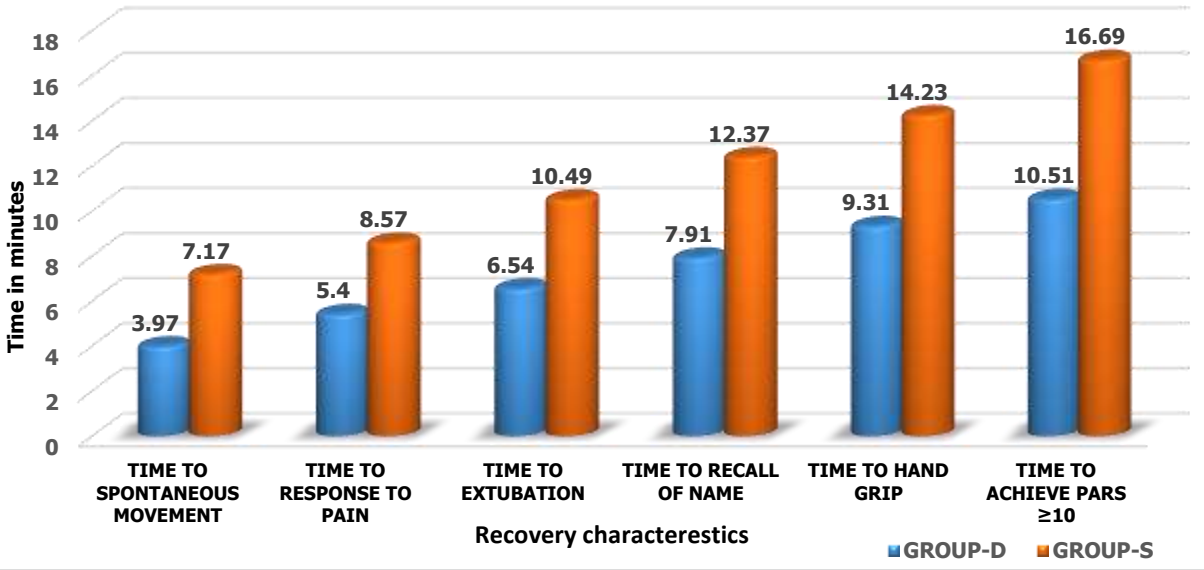

Figure 3. Comparison of Post-Operative Recovery Characteristics (Group D-Desflurane Group, Group S-Sevoflurane Group)

DISCUSSION

General anaesthesia is said to be medically induced state of loss of consciousness with induced immobility, amnesia, analgesia and areflexia resulting from administration of various general anaesthetic agents. With the discovery of less soluble volatile anaesthetics which maintains haemodynamics well and are having predictable intraoperative and recovery characteristics, general anaesthesia was made as the technique of choice for various surgeries. Haemodynamic stability and early recovery are the most important part of a standardized balanced anaesthesia technique which may lead to faster operating room turn over time, shorter recovery room stays, and earlier discharges to home.[4,5,6,7] Maintenance of deep plane of anaesthesia with stable haemodynamic and providing of absolute immobility at the same time ensure early smooth recovery to prevent bleeding and assess vocal cord are the challenges of anaesthesiologists during thyroid surgeries.[8]

In our study, 70 ASA PS I-II patients who had undergone thyroidectomy under general anaesthesia were compared for their intra-operative haemodynamics, post-operative emergence and recovery characteristics in desflurane and sevoflurane based anaesthesia along with nitrous oxide for maintenance of anaesthesia.

The heart rate and mean arterial pressure, before any medication was considered as the baseline HR and MAP. The HR and MAP of desflurane group were compared with that of sevoflurane group at regular intervals. Also, HR and MAP noted in each group at regular interval was compared with the baseline value of that respective group and the percentage difference from mean baseline was noted. This percentage difference of MAP and HR from baseline was compared between desflurane and sevoflurane groups.

The mean HR and MAP of desflurane and sevoflurane groups were comparable and the difference was statistically insignificant (P value > 0.05). Both, desflurane and sevoflurane maintained MAP and HR within 20 % of the baseline values. Rescue doses of Fentanyl were not required for maintaining haemodynamics in both groups. Hypotension was easily managed with fluid replacement and none of the patients required exclusion and aggressive management for haemodynamic stability. So, in our study there were no difference in haemodynamic profiles of desflurane- and sevoflurane-based anaesthesia in thyroid surgery.

The volatile agent was discontinued after skin closure at the end of the surgery and the recovery parameters were evaluated by another blinded anaesthesiologist at one-minute interval. Time taken for spontaneous movement, response to pain, extubation, recall of name, and hand grip were shorter in the desflurane group compared to sevoflurane group. Post anaesthesia recovery score of Aldrete and Kroulik ≥ 9 was achieved earlier in the desflurane group compared to sevoflurane group. So, the early recovery characteristics were better in desflurane based anaesthesia compared to sevoflurane.

The study by Nathanson et al.[9] conducted on 52 patients undergoing laparoscopic sterilisation under general anaesthesia were divided into two groups to receive desflurane or sevoflurane for maintenance of anaesthesia. Heart rate was lower in sevoflurane from the time induction to incision. They found that sevoflurane and desflurane provided similar intra-operative conditions during the maintenance period of anaesthesia. Use of desflurane for maintenance of anaesthesia resulted in rapid emergence (4.8 + / - 2.4 vs 7.8 + / - 3.8 min) and early extubation (5.1 + / - 2.2 vs 8.2 + / - 4.2 min) compared to sevoflurane. Although recovery was more rapid after desflurane, there was no difference in later recovery end-points. This study results were consistent with our study findings.

S Gergin et al.[10] conducted a study to compare the haemodynamic, emergence and recovery characteristics of sevoflurane with those of desflurane in nitrous oxide anaesthesia in forty patients undergoing general surgery. They found out that time to extubation (3.6 ± 1.66 vs 4.4 ± 1.72), recall of name (6.1 ± 1.44 vs 8 ± 3.01) and handgrip

on command (5.9 ± 1.52 vs 8 ± 2.79) and achieving PARS (Post Anaesthesia Recovery Score of Aldrete and Kroulik) ≥ 9 were shorter in the desflurane group, whereas the haemodynamic stability remained similar in both groups. They concluded both desflurane and sevoflurane exhibits haemodynamic stability during intra-operative period, but recovery profile was better in desflurane group.

Earl M. Strum et al.[11] compared post-operative recovery after desflurane versus sevoflurane anaesthesia in morbidly obese adults who underwent gastrointestinal bypass surgery via an open laparotomy. The time from discontinuation of volatile anaesthetic administration to eye opening, squeezing hand, tracheal extubation and orientation were significantly shorter in patients given desflurane than in patients given sevoflurane. Morbidly obese adult patients who underwent major abdominal surgery woke significantly faster and had higher oxygen saturation on entry to the post anaesthesia care unit after desflurane anaesthesia compared to sevoflurane.

Meta-analysis, conducted by Macario A et al.[12] of 22 studies done on a total of 746 patients who received sevoflurane and 752 who received desflurane were compared about their post-operative recovery characteristics. Patients in desflurane group recovered 1 - 2 minutes quicker compared sevoflurane. They obeyed commands 1.7 minutes faster (P < 0.001; 95 % confidence interval [CI], 0.7 - 2.7 minutes), were extubated 1.3 minutes sooner (P = 0.003; 95 % CI, 0.4 - 2.2 minutes) and were oriented 1.8 minutes earlier (P < 0.001; 95 % CI, 0.7 - 2.9 minutes) than sevoflurane. Similar to our study they also had early recovery with desflurane compared to sevoflurane. Here haemodynamic profiles were not compared.

Chudasama PA and Mehta MV[13] conducted study on 42 patients to compare haemodynamic parameters and recovery characteristics between sevoflurane and desflurane in patients undergoing day-care surgical procedure. In contrast to our study they found that mean heart rate and mean arterial pressures were significantly lower in desflurane group compared to sevoflurane group. But similar to our study they also found that the recovery characteristics were better in desflurane based anaesthesia than sevoflurane.

Even though the early recovery following desflurane based anaesthesia is evident from various studies, readiness for home discharge was not favouring use of desflurane as per the study conducted by Jindal R and colleagues.[14] This may be because early recovery characteristics are better with desflurane as evidenced by our study whereas intermediate recovery points like readiness for discharge are similar in both sevoflurane and desflurane which was not investigated in our study.

CONCLUSIONS

Desflurane and sevoflurane provide similar intra-operative haemodynamic profiles with good haemodynamic stability when used for maintenance of general anaesthesia in elective thyroid surgeries. However, the recovery and emergence from general anaesthesia was more rapid after desflurane than sevoflurane based anaesthesia.

Limitations

The limitation of this study is not being able to provide a blinded investigator during the intra-operative period when the haemodynamic parameters were assessed. However, for assessing the recovery parameters, a blinded investigator was posted after stopping the volatile agent. Any effect on post-operative analgesic requirement, effect on nausea and vomiting, monitoring for any acid base disturbance and incidence of cough due to airway irritation were not done in our study. Effects on surgeries lasting more than 2 hours also need to be addressed because emergence after prolonged exposure to general anaesthesia is very important. Reduction in cost due to lesser use of neuromuscular blocking drugs, opioids, and early discharge from the ICU could impinge on the decision regarding use of either sevoflurane or desflurane in an ambulatory setting which needs to be evaluated.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

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