Original Article

Desflurane for ambulatory anaesthesia: A comparison with sevoflurane for recovery profile and airway responses

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ABSTRACT

Background and Aims: Desflurane and sevoflurane have low blood gas solubility co-efficients, allowing a rapid awakening from anaesthesia. However, desfluraneis pungent and may cause airway irritability. We compared desflurane and sevoflurane with respect to recovery and occurrence of adverse airway responses in spontaneously breathing patients while using the ProSeal™ laryngeal mask airway (LMA).**Methods:** Ninety-four adult patients undergoing hysteroscopic procedures were divided into sevoflurane (S) group or desflurane (D) group. Patients were premedicated with midazolam 0.03 mg/kg and fentanyl 1μg/kg. Anaesthesia was induced with propofol 2.0–2.5 mg/kg, followed by insertion of a ProSeal™ LMA. Adverse airway responses such as cough, hiccups, laryngospasm and breathholding were recorded. In the post-operative period: time to awakening, response to verbal commands, orientation, ability to sit with support and the recovery room Aldrete score were recorded. **Results:** Three patients in group S (6.4%) and six patients (13.3%) in Group D had adverse airway events. The mean time to eye opening (Group S-10.75 ± 7.54 min, Group D-4.94 ± 1.74 min), obeying verbal commands (Group S-13.13 ± 8.75 min, Group D-6.55 ± 1.75 min), orientation (Group S-15.42 ± 8.46 min, Group D-6.23 ± 2.4 min) and to sit with support (Group S-36.09 ± 12.68 min, Group D-14.35 ± 3.75 min) were found to be lesser with desflurane than with sevoflurane ($P < 0.001$). The mean time to recovery was delayed in Group S-46.00 ± 12.86 min compared to Group D-26.44 ± 5.33 min ($P < 0.001$). **Conclusion:** Desflurane has faster awakening properties than sevoflurane without an increase in adverse airway events when used during spontaneous ventilation through a ProSeal™ LMA along with propofol and fentanyl.

Key words: Airway responses, ambulatory anaesthesia, desflurane, emergence, sevoflurane

INTRODUCTION

With the advent of minimally invasive surgical techniques, ambulatory surgeries are on the rise, leading to an increased demand for fast tracking. This necessitates early recovery in the form of clear-headedness, control of protective airway reflexes and satisfactory relief from pain and emesis.[1] As a result, there is a need for the use of short-acting anaesthetic drugs for a better quality of recovery. Sevoflurane and desflurane have been in use for ambulatory anaesthesia as they both have properties of an ideal agent. Desflurane has lower blood gas solubility than sevoflurane resulting in rapid induction and emergence from anaesthesia.[2] However, desflurane is pungent and can be irritant to the airway leading to coughing, breathholding, laryngospasm and copious secretions.[3,4] This property may make sevoflurane an agent of choice for cases on spontaneous respiration.

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There are limited studies on desflurane with spontaneous breathing. We decided to compare the efficacy of desflurane and sevoflurane for maintenance and recovery of anaesthesia and to evaluate airway responses in spontaneously breathing patients using the ProSeal™ laryngeal mask airway (LMA) during ambulatory surgeries. We hypothesise that desflurane has a faster recovery profile but may cause increased airway events during spontaneous ventilation when compared to sevoflurane.

METHODS

Institutional Ethics Committee approval and written informed consent from the participating patients was obtained for this study. A total of 94 female patients between 18 and 65 years belonging to the American Society of Anesthesiologists' physical status I and II undergoing hysteroscopic gynaecological surgery under general anaesthesia were randomly allocated into two groups using computer-generated codes kept in sealed opaque envelopes. Group S patients who received sevoflurane for maintenance of anaesthesia, while Group D patients received desflurane for maintenance of anaesthesia.

Patients who were morbidly obese, with distorted airway anatomy or at risk of gastric aspiration were excluded from the study. After securing an intravenous (IV) line, Ringer's lactate infusion was started. Non invasive blood pressure, electrocardiogram and pulse oximeter (SPO_2) were attached, followed by pre-medication with IV midazolam 0.03 mg/kg and fentanyl 1μg/kg. Simultaneously, pre-oxygenation with 100% oxygen was given for 3 min. After 3 min, anaesthesia was induced with propofol 2.0–2.5 mg/kg. After abolition of the eye lash reflex and adequate jaw relaxation, an appropriate size ProSeal™ LMA according to weight of the patient was inserted with the digital technique. If the LMA could not be satisfactorily placed at the first attempt, additional bolus doses of propofol (20–40 mg) were administered until satisfactory conditions were achieved. After confirming the placement of ProSeal™ LMA, anaesthesia was maintained with 50% oxygen and 50% nitrous oxide and either sevoflurane or desflurane (according to random allocation) on a closed circuit (North American Drager Primus, Draeger Medical GmbH, Germany).

Total fresh gas flow during first 6 min was standardised and kept at 6 L/min with vaporiser dial concentration of 6% for desflurane and 2% for sevoflurane. Initially, patients were given intermittent positive pressure ventilation. At the end of 6 min, total fresh gas flow was reduced to 1 L/min, and the dial concentration was reduced to 3% for desflurane and 1% for sevoflurane, and patients were allowed to breathe spontaneously. All patients received ondansetron 0.1 mg/kg IV. At the end of the procedure, the volatile anaesthetic and nitrous oxide were turned off, and 100% oxygen was given. After confirming nitrous oxide removal from circuit with respiratory gas monitoring , the ProSeal™ LMA was removed. Intraoperative haemodynamic variables, namely, heart rate, systolic blood pressure, diastolic blood pressure, SpO_2, respiratory gas monitoring, end-tidal carbon dioxide, respiratory rate, minimum alveolar concentration (MAC) and end-tidal concentration of volatile agent were monitored every 5 min throughout the surgery. We studied the occurrence of cough, hiccups, breathholding (>10 s) and laryngospasm during maintenance of anaesthesia and in the post-operative period. Another qualified anaesthetist unaware of the inhalational agent used, assessed the time taken from switching off of the vaporiser to eye opening, time to obey verbal commands (tongue protrusion), time to sit with support, time to shift out of the recovery room and orientation in time, place and person. Coughing was graded as mild for 1–3 coughs, moderate for 4–7 coughs and severe for 8 or more cough. Breathholding was graded as 1 for 10–20 s, 2 for 20–30 sand 3 for >30 s. Laryngospasm was graded as 1 for phonation and stridor <15s, 2 for phonation and stridor >15s and 3 for duration >15s requiring IV medication to treat. Patients were shifted to the recovery room in propped up position. Humidified oxygen was administered through a face mask, and recovery characteristics were recorded every 5 min with the help of modified Aldrete scoring system.[5] A score of ≥8 was considered suitable for discharging the patient from the post-anaesthesia care unit to the ward.

Sample size was calculated considering typeI error with alpha = 0.05 and power of 0.80. Assuming a 35% occurence in airway events with desflurane based on a previous study[6] and 10% in sevoflurane group based on a pilot study we did with sevoflurane, a minimum of 43 patients were required in each group. Expecting a few drop outs (requiring endotracheal intubation and protocol deviation), a total of 94 patients were included in the study.

Data analysis was done with the help of SPSS software version 22 IBM Corp.Armonk, NY. Quantitative data

were presented with the help of mean and standard deviation. Comparison between study groups was done with the help of unpaired *t*-test or Mann–Whitney test. Qualitative data were presented with the help of frequency and percentage table. Chi-square test was used to assess the association amongst study group. $P < 0.05$ was considered statistically significant.

RESULTS

Ninety-four patients were randomised, out of which 92 patients completed the study. Two patients in the desflurane group were excluded because intraoperatively they required intubation due to improper seal of LMA [Figure 1]. The demographic details of patients such as age, weight, height were comparable in both the groups [Table 1]. Also average MAC value in Group S 1.09 ± 0.07 and Group D 1.10 ± 0.08, total duration of surgery (in min) in Group S 22.13 ± 4.97 and Group D 21.89 ± 4.97 were comparable.

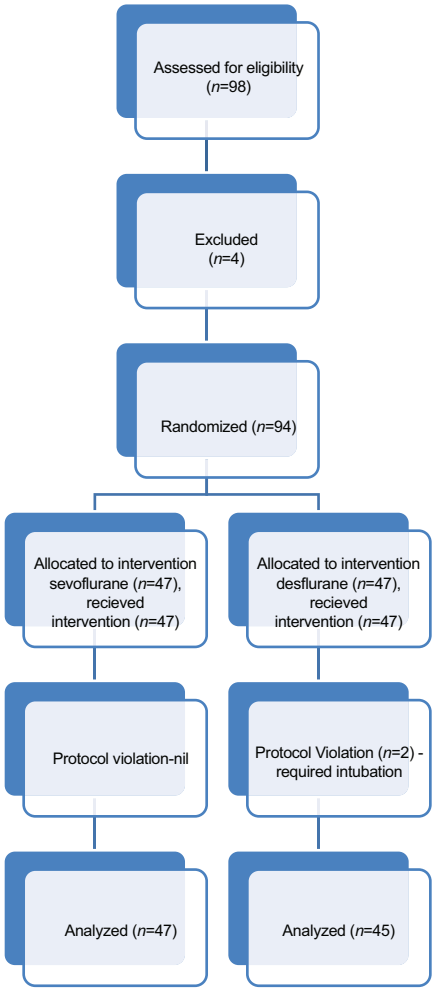

Figure 1: Consort chart

Adverse airway events such as cough, hiccups, breathholding and laryngospasm were found in 6.4% of patients in Group S and 13.3% of patients in Group D ($P = 0.148$). Thus, the difference in the incidence of adverse airway events was not significant [Figure 2].

The mean time to eye opening (in min) was10.75 ± 7.54 in Group S, and 4.94 ± 1.74 in GroupD ($P < 0.001$). Both time (in min) to obey verbal commands (13.13 ± 8.75 in Group S and 6.55 ± 1.75 in Group D) and mean time to be oriented in time place and person (15.42 ± 8.46 in Group S and 6.23 ± 2.4 in Group D) occurred earlier in desflurane group as compared to sevoflurane group ($P < 0.001$). The mean time (in min) to sit with support was 36.09 ± 12.68 in Group S compared to 14.35 ± 3.75 in Group D ($P < 0.001$) [Table 2]. The mean total time (in min) to recovery was greater with sevoflurane (46 ± 12.86) compared to desflurane (26.44 ± 5.33), $P < 0.001$[Table 2].

DISCUSSION

The result of our study shows that there is no difference in the occurrence of airway responses such as coughing, hiccups, breath holding and laryngospasm between desflurane and sevoflurane when used during spontaneous breathing with the ProSeal™ LMA for short gynaecological surgeries. We also found that desflurane group showed faster recovery in terms of lesser time to opening eyes, response to simple verbal

Table 1: Patient demographics

Demographic variables	Group S (*n*=47)	Group D (*n*=45)
Age (year)	51.77±8.94	51.04±9.62
Weight (kg)	63.68±8.84	61.56±10.87
Heigwht (m)	1.57±0.06	1.6±0.06

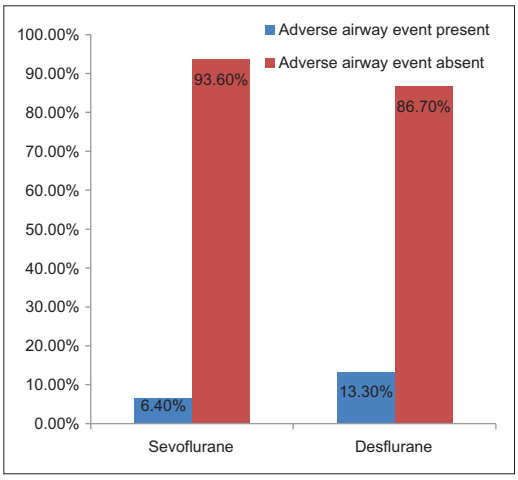

Figure 2: Comparison of airway responses amongst the study groups

Table 2: Recovery variables

Recovery variables	Group S (*n*=47)	Group D (*n*=45)	CI (%)	*P*
Opening eyes (min)	10.75±7.54	4.94±1.74	>95	<0.001
Response to verbal commands (min)	13.13±8.75	6.55±1.75	>95	<0.001
Orientation (min)	15.42±8.46	6.23±2.4	>95	<0.001
Sit in bed with support (min)	36.09±12.68	14.35±3.75	>95	<0.001
Total time in recovery (min)	46.00±12.86	26.44±5.33	>95	<0.001

CI – Confidence interval

commands such as protruding tongue, orientation in time, place and person and clear-headed recovery with the ability to communicate freely as compared to those belonging to sevoflurane group.

When compared to an endotracheal tube, use of the laryngeal mask in general anaesthesia, especially in day care, reduces the incidence of post-operative airway complications.[7] However, studies on airway events with desflurane and LMA during spontaneous breathing are limited. Sevoflurane is sweet-smelling and non-irritant to the airway and is considered to be most suitable for inhalational induction as well as maintenance of anaesthesia. Desflurane has lower blood gas solubility than sevoflurane and is considered to have a faster recovery profile.[7] It is well documented that desflurane can cause airway irritation as it is the most pungent of all volatile anaesthetics. When given in high concentrations above threshold for respiratory irritation (1–1.5 MAC in 100% 02), there could be chances of adverse airway events. However, irritation of the airway may not occur till end-tidal concentration of 5.4% (upto 1 MAC in 100% 02).[8]

We found that the adverse airway events occurred in 13.3% in desflurane group and 6.4% in sevoflurane group, but this difference was statistically insignificant. We attribute our findings to our standardised protocol of pre-treatment with fentanyl 1μg/kg in both the groups that may have abolished the airway responses. Similar findings were seen in a study where exceeding more than 1 MAC did not have an increased incidence of breathholding or coughing. Administration of fentanyl as pre-medication by them may have decreased the incidence of coughing or breathholding with desflurane.[9]

Another study had used 50 mcg fentanyl and found similar incidence of airway events in the two groups, despite the reputed greater airway irritability of desflurane.[10] Similar findings were seen in a study where on giving fentanyl 1μg/kg as pre-medication, there was a decreased incidence of coughing on induction of anaesthesia with desflurane by 80%.[11]

A recent study used 1 MAC desflurane with fentanyl and observed no difference in the frequency and severity of upper airway events.[12] However, even after administration of fentanyl 1μ/kg, there were significantly more adverse responses with desflurane at 12% concentration in 100% oxygen. This may be attributed to high desflurane vapour concentration used.[3] No significant difference in airway irritation between desflurane and sevoflurane was found when used in smokers, even at higher concentrations of the agents (>1MAC), making desflurane suitable even in patients with reactive airways.[13] Due to its pungency, desflurane is not preferred for induction in children, but due to early emergence properties, it may be a preferred agent in neurosurgical patients and ambulatory surgeries.[14]

A meta-analysis on recovery with desflurane found three trials with short procedure times. In one trial, they failed to show an advantage of desflurane for early recovery which they attributed to the short duration, while in the other two trials, they were unable to determine the effect of anaesthesia duration on outcome.[15] In our study, the average duration of surgery was 20 min. We found significantly faster awakening of patients who received desflurane than in those with sevoflurane. Early recovery in terms of eye opening, response to verbal commands, time to be oriented and sitting with support was all faster with desflurane as compared to sevoflurane. The addition of fentanyl did not prolong the recovery time. Awakening times in our study were similar to the another study where fentanyl was not a part of anaesthesia maintenance showing that addition of fentanyl did not affect the recovery profile.[16]

Our findings of early recovery with desflurane are similar to various studies where in they found that time to eye opening and obeying commands was earlier in desflurane than sevoflurane.[5,12,17] A similar analysis documented the differences in anaesthetic kinetics of 2 and 4h of 1.25 MAC of desflurane (9.0%) versus sevoflurane (3.0%). They concluded that

regardless of the duration of anaesthesia, elimination is faster and recovery is quicker for desflurane than for sevoflurane. They attributed this to low blood: gas solubility of desflurane.[18] Another study also found similar results that recovery profile (psychomotor, time to sit in the bed) is faster with desflurane compared to sevoflurane.[19]

We found that the mean total time in recovery room was significantly less in desflurane group compared to sevoflurane group. The above findings of early recovery indicate that desflurane due to its low blood gas solubility (blood: Gas partition coefficient is lowest for desflurane [0.45], followed by sevoflurane [0.65]), and rapid elimination with little or no residual metabolites causes a clear-headed recovery, combined with stable haemodynamics, helped to achieve Aldrete score >8 faster than sevoflurane. Our findings corroborate with recent study which found similar changes in the immediate and intermediate recovery which was significantly faster after desflurane than sevoflurane anaesthesia, thus contributing to fast tracking and early discharge of patients.[20] Due to the higher cost of desflurane, it may increase the cost of anaesthesia. However, when used with low flows, desflurane has been found to be less expensive than sevoflurane.[21]

CONCLUSION

Desflurane has an overall better quality of early recovery in patients as compared to sevoflurane. The fear of potential adverse airway events may restrict the usage of desflurane, especially with spontaneously breathing patients with LMA. However, our study did not show any increase in airway events even at MAC>1 which may be attributed to pre-treatment with fentanyl. Systematic review could be conducted to evaluate whether the use of fentanyl decreases the incidence of airway events. Furthermore, further studies will be required on smokers, patients with reactive airway and obese patients to evaluate the incidence of adverse airway events, especially at higher MAC. As the incidence of airway events that we got with desflurane (13.3%) is lower than that assumed for sample size calculations, the study is underpowered to detect a difference. We have only evaluated female subjects undergoing hysteroscopic gynaecological surgery which limits the generalisation of our results. Furthermore, we were unable to eliminate any bias that the administrator might have had to either agents as blinding was impractical.

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Conflicts of interest

There are no conflicts of interest.

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