

Original article:

A Randomized Controlled Study Comparing Maintenance, Emergence and Recovery Characteristics of Sevoflurane and Desflurane in Short Procedure Surgeries Done Under Laryngeal Mask Airway

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ABSTRACT

Background: Desflurane and Sevoflurane are two commonly administered inhaled anaesthetic agents for outpatient surgeries. Aim of the study was to compare effect of Desflurane and Sevoflurane on airway responses during, immediate after surgery and while recovery from Anaesthesia in patients undergoing short surgical processes using LMA.

Subjects and Methods: A prospective randomized controlled study was conducted in 56 ASA grade I or II patients, posted for minor surgical procedures. Patients were divided in two groups, Group D received Desflurane+50% N₂O (n= 28) and Group S received Sevoflurane+ 50% N₂O (n=28). Vitals were measured preoperatively, intraoperative and till the end of surgery(max 120 minutes).Incidence of respiratory events –coughing, breath holding and laryngospasm were recorded intraoperative as well as in postoperative period till the patient achieved modified Aldrete score of 10. Time from discontinuation of anaesthesia to eye opening, respond to command and orientation to time and place, at an interval of every 2 minutes was determined. Time to be fit for discharge from PACU defined by sitting, first oral intake (20 ml. of water), standing and to ambulate unassisted was recorded every 15 minutes once the Modified Aldrete score of 10 was achieved.

Results: More rise in mean heart rate was seen in Group D intra operatively (p value < 0.05).There was no statistical difference in mean systolic and mean diastolic blood pressure between the two groups. There was no significant difference observed in respiratory rate and saturation at induction, intraoperative and postoperatively among both the groups. Time taken to open the eyes, to obey the verbal commands, the time taken for orientation and to achieve Modified Aldrete score 10 was shorter in the group D than the group S (p value < 0.001). Time taken to sit, to first oral intake, and time taken for standing and ambulate unassisted was shorter in the group D than the group S (p value < 0.001).

Conclusion: The intraoperative hemodynamic characteristics were comparable with both Desflurane and Sevoflurane. The emergence and Recovery in PACU (post anaesthesia care unit) both were faster with administration of Desflurane compared to Sevoflurane.

Keywords: laryngeal mask airway (LMA), Sevoflurane, Desflurane

INTRODUCTION:

Laryngeal mask airway (LMA) is the most popular supraglottic airway device^(1,2) which was designed as a new concept but today it has a firm position in anaesthetic practice⁽³⁾. It is used electively where tracheal intubation is

not required, mostly in short surgical procedures. LMA has minimal risks of failed ventilation and aspiration and is less invasive compared to intubation. It has been proved extremely useful in managing the difficult airway. Desflurane, a newly introduced potent, inhaled anesthetic⁽⁴⁾, is used for maintenance of general anaesthesia. Being low soluble in blood and body tissues Desflurane facilitates a rapid induction of anaesthesia and precise control of depth of anaesthesia (during maintenance of anaesthesia). Sevoflurane, a volatile liquid for inhalation, is halogenated ether. It allows rapid inhalation induction, maintenance and rapid recovery, its haemodynamic and respiratory depressive effects are moderate and well tolerated⁽⁵⁾ Aim of our study was to assess the effect of Sevoflurane and Desflurane on incidence of coughing, breath holding and laryngospasm during maintenance of the anaesthesia and during emergence from the anaesthesia. And to compare early emergence (eye opening, respond to command, orientation, fast tracking score) upon leaving operating room & late recovery (sitting, first oral intake, standing, ambulate unassisted) between two groups.

SUBJECTS AND METHODS:

This Open Label, Randomized Controlled, Prospective Study was conducted after approval from hospital's ethical committee over a period of 6 months. A written and informed consent was taken from the patient after explaining the procedure to the patient.

Sample size calculation had been done using statistical analysis software strata 11. Study was conducted on 56 ASA grade I and II patients, aged between 19 to 60 years who underwent minor surgical procedures. They were randomized in two groups by periodic randomization.

Group S- Sevoflurane + N₂O (nitrous oxide)

Group D- Desflurane + N₂O (nitrous oxide)

Study was conducted in patients scheduled for superficial/minor surgical procedures. For example, General surgical procedures including Resection of lipoma, hernia surgery, Urological surgeries including Insertion or removal of ureteric stent, laser lithotripsy Gynecological surgeries including endometrial biopsy, colposcopy and cervical biopsy. Orthopedic surgeries including arthroscopic surgeries. Exclusion criteria includes Patient who were Unable to provide consent, ASA grade 3/4/5, Patients with clinically significant uncontrolled systemic diseases and Duration of surgery more than 2 hours. Preanaesthetic evaluation was done on previous day of surgery. Nil per oral status of at least 6 hours was maintained. Premedication with Tab Pantoprazole 40 mg. on previous night and Tab Alprazolam 0.25 mg was given on previous night.

On Arrival to Operation Room Standard monitoring include electrocardiogram, pulse oximetry, end tidal concentration of carbon dioxide, non-invasive blood pressure (NIBP) & temperature probe was connected. Patient's baseline heart rate, NIBP and SpO₂ were recorded.

Intravenous fluid, normal saline or ringer lactate was administered according to fluid administration guideline. Preoxygenation with 100% oxygen for 3 minutes using fresh gas flow of 10 L / min was done. Inj. Glycopyrrolate 0.004mg/kg IV, Inj. Ondansetron .08mg/kg IV and Inj. Fentanyl at dose of 2µg/kg IV was given prior to induction. Anaesthesia was induced with inj. Propofol at dose 2 mg/kg-a dose sufficient to allow insertion of LMA.

Once the LMA was positioned and spontaneous ventilation resumed, group D received Desflurane + 50% N₂O and group S received Sevoflurane+ 50% N₂O at a maintenance total gas flow of 1lit/min. MAC value was assumed to be

equal to 6% Desflurane and 1.85% Sevoflurane. Pulse, blood pressure, respiratory rate and O₂ saturation were measured every minute for first 5 minutes and thereafter every 5 minute till the patient is shifted to recovery room. Anaesthetic concentration, drug dose delivered and bolus requirement of Propofol and opioids for each patient was also recorded. Incidence of respiratory events –coughing, breath holding and laryngospasm was recorded intraoperative as well as in post-operative period till the patient has achieved Modified Aldrete score of 10. Once the surgery was over anaesthetic agent was discontinued, patient was ventilated with 100% oxygen and the LMA was removed once patient had regained consciousness. Pain control was done with injection Paracetamol 1000 mg. IV. Patient was shifted to recovery room for observation. Time was determined from discontinuation of anaesthesia to eye opening, respond to command and orientation to time and place, at an interval of every 2 minutes. Modified Aldrete score was obtained at every 5 minute interval after discontinuation of anaesthesia. Finally time to be fit for discharge defined by sitting, first oral intake (20 ml. of water), standing and to ambulate unassisted was recorded by every 15 minutes once the Modified Aldrete score of 10 is achieved.

Primary endpoint of study was following the discontinuation of inhalational anaesthetic, the mean time taken to open eyes. Secondary endpoints of study were 1. Respiratory events such as cough, laryngospasm at the time of emergence. 2. Early recovery parameters such as respond to command, orientation, time taken to achieve modified aldrete score. 3. Late recovery parameters like sitting, first oral intake, standing and ambulated unassisted.

Sample size calculation was based on previous study with the primary endpoint, mean time to eye-opening will be in Desflurane group (5.30±2.5) min and (7.90±4.10) min Sevoflurane group with α of 0.05 and power of the study (1- β ²) at 80%, to detect a minimum of 2.6 min difference between the two groups for eye open, the sample size was calculated to be approximately 28 in each group. We included thirty patients in each group to compensate for possible dropouts. The patients' data and characteristics the recovery time will be categorized and analyzed appropriately using student's unpaired t-test and Chi-square test. A $p < 0.05$ was considered as statistically significant and a $p < 0.001$ as statistically highly significant. The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 22.0 for Windows). All quantitative variables were estimated using measures of central location (mean, median) and measures of dispersion (standard deviation). Normality of data was checked by measures of Kolmogorov Smirnov tests of normality. For normally distributed data means were compared using student's t-test for two groups. For skewed data or for scores (for VAS score, motor power) Mann-Whitney test was applied. Proportions were compared using Chi square or Fisher's exact test whichever was applicable. All statistical tests were two-sided and performed at a significance level of $\alpha=0.05$; $p < 0.05$ considered as significance level

RESULTS:

Table 1: comparison between two groups according to demographic data :

Parameters	Group S	Group D	P Value
Age	39.09±11.72	33.82±10.91	0.088
Gender	M (53.57%) F (46.53%)	M (57.14%) F (42.86%)	0.788
Height	163.35±8.06	166.03±9.36	0.262
Weight	69.46±8.51	68.64±9.54	0.735
BMI	26.52±2.43	25.79±2.73	0.124
ASA Grading	I (64.29%) II (35.71%)	I (67.86%) II (32.14%)	0.777

Table 2: Comparison of baseline vital parameters in both groups:

Parameters	Group S (n=28) Mean ± SD	Group D (n=28) Mean ± SD	p value
Heart Rate (per minute)	85.68±4.65 (76 – 92)	84.53±6.88 (67 – 98)	0.47
Systolic Blood pressure (mm Hg)	125.68±8.96 (112 – 148)	123.28±10.68 (98 - 146)	0.36
Diastolic Blood pressure (mmHg)	80.25±6.13 (68 – 94)	78.68±8.57 (60 – 94)	0.43
SpO ₂ (%)	98(98, 100)	98.25 (98.05,100)	0.992
Respiratory rate (per minute)	19.5±1.53 (16 – 22)	20.11±1.29 (18 – 22)	0.11

Table 3: Comparison of change in heart rate per minute among the two groups:

Heart rate (b/min) Duration (in min.)	Group S (n=28)	Group D (n=28)	p value
Baseline	85.67±4.65	84.32±6.73	0.384
Induction	86.42±6.02	86.14±5.38	0.852
3 min.	83.92±5.90	87.85±5.29	0.011
10 min.	81.46±6.26	88.60±5.64	<0.0001
20 min.	81.64±5.71	89.67±4.88	<0.0001
40 min.	81.85±6.35	90.60±5.07	<0.0001
60 min.	82.00±6.35	90.78±4.68	<0.0001
80 min.	81.75±5.99	90.96±4.15	<0.0001
100 min.	81.55±5.67 (n=18)	91.10±2.49 (n=19)	<0.0001
120 min.	84.00±0.00 (n=2)	90.00±0.00 (n=2)	NA

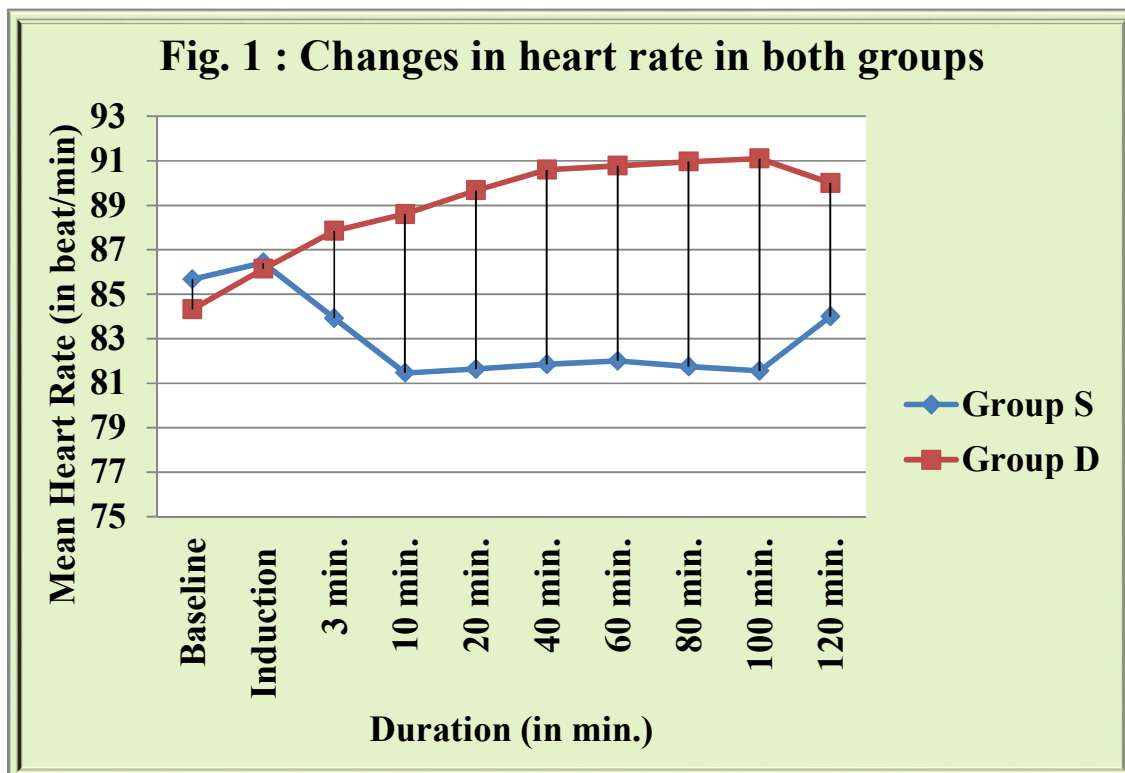


Table4: Changes in systolic blood pressure in both groups per minutes

SBP (mmHg)	Group S (n=28)	Group D (n=28)	P value
Duration (in min.)	95% C.I	95% C.I	
Baseline	125.67±8.95	123.28±10.68	0.367
Induction	125.32±7.85	123.17±8.35	0.327
3 min.	119.39±7.17	119.03±7.37	0.854
10 min.	112.96±5.76	116.32±7.55	0.067
20 min.	109.92±5.68	114.14±6.79	0.014
40 min.	108.92±5.98	113.17±6.37	0.012
60 min.	107.82±5.50	111.10±6.67	0.049
80 min.	105.92±5.38	108.75±5.49	0.057
100 min.	104.71±4.14 (n=21)	106.00±4.50 (n=15)	0.382
120 min.	106.50±6.36	0.00	NA

Table 5 : Comparison of Changes in Diastolic blood pressure in both groups per minutes

DBP (mmHg)	Group S (n=28)	Group D (n=28)	p value
Duration (in min.)	95% C.I	95% C.I	
Baseline	80.25±6.12	80.75±7.25	0.997
Induction	80.81±6.40	78.92±8.56	0.527
3 min.	76.75±5.74	76.32±7.36	0.809
10 min.	72.46±5.68	74.39±6.72	0.251
20 min.	70.14±5.54	73.10±6.26	0.066
40 min.	69.00±4.77	73.21±6.26	0.006
60 min.	67.64±4.02	71.28±6.00	0.010
80 min.	66.53±3.75	69.89±5.64	0.011
100 min.	65.16±3.89 (n=18)	66.94±5.15 (n=17)	0.257
120 min.	67.50±0.70 (n=2)	0.00	NA

Table 6: Comparison of Changes in Respiratory rate in both groups per minutes:

RR (minute) Duration (in minute)	Group S (n=28) 95% C.I	Group D (n=28) 95% C.I	P value
Baseline	19.50±1.52	20.10±1.28	0.113
Induction	21.71±1.86	21.75±1.62	0.939
Intra Op	13.92±1.01	14.14±0.93	0.414
Post Op	18.32±1.38	18.32±1.58	0.998

Table7: Comparison of Changes in oxygen saturation in both groups per minutes:

SPO ₂ (%) Duration (in min.)	Group S (n=28) (Median ± IQR)	Group D (n=28) (Median ± IQR)	p value
Baseline	98(98, 100)	98.25 (98,100)	0.992
Induction	100 (100,100)	100 (100,100)	NA
3 min.	100 (100,100)	100 (100,100)	NA
10 min.	100 (100,100)	100 (100,100)	NA
20 min.	100 (100,100)	100 (100,100)	NA
40 min.	100 (100,100)	100 (100,100)	NA
60 min.	100 (100,100)	100 (100,100)	NA
80 min.	100 (100,100)	100 (100,100)	NA
100 min.	100 (100,100)	100 (100,100)	NA
120 min.	100 (100,100)	100 (100,100)	NA

Table 8: Comparison of Respiratory Events among Two Groups:

Respiratory Observations	Group S (N= 28)		Group D (N= 28)	
	Maintenance	Emergence	Maintenance	Emergence
Coughing	0	0	0	0
No coughing	0	0	0	0
Single cough with SpO ₂ >95%	0	0	0	1
Multiple cough with SpO ₂ > 95%	0	0	0	3
Multiple cough with SpO ₂ < 95%	0	0	0	0
Multiple cough with SpO ₂ < 95%, require IV medication	0	0	0	0
Breath Holding	0	0	0	0
Laryngospasm	0	0	0	0

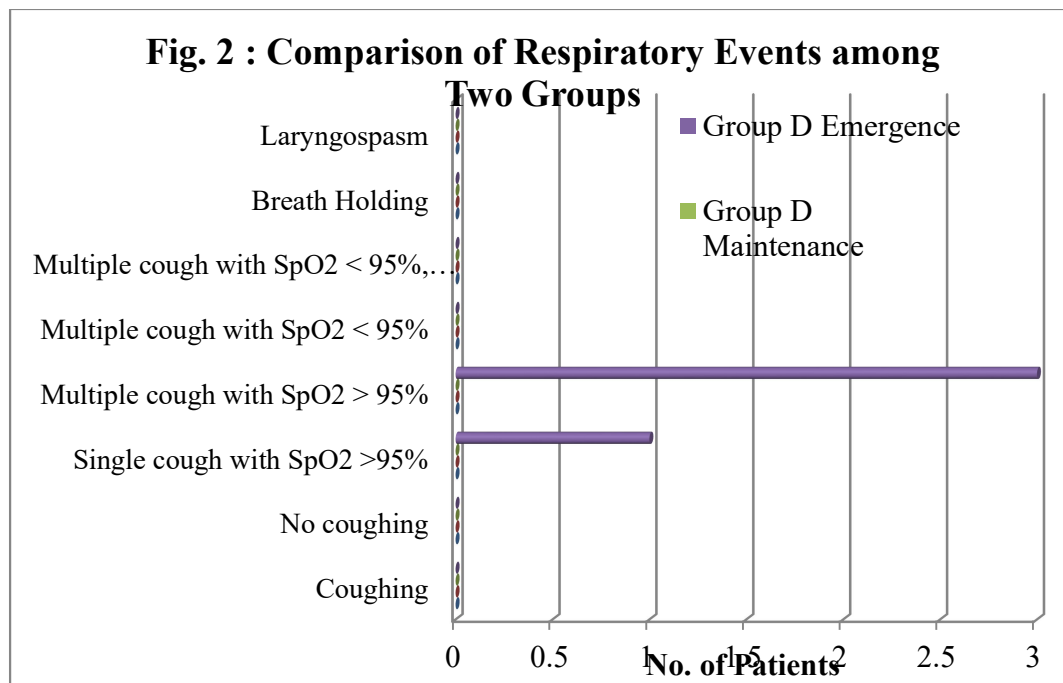


Table 9: Early Recovery parameters among the two groups

Early Recovery Parameters	Group S (N= 28) Mean ± SD	Group D (N= 28) Mean ± SD	P value
Eye opening	17.07±2.40	6.92±1.67	<0.001
Respond to command	17.50±2.22	7.07±1.69	<0.001
Orientation	18.53±2.22	7.68±1.91	<0.001
Min. to Modified Aldrete score	19.82±2.51	9.46±2.08	<0.001

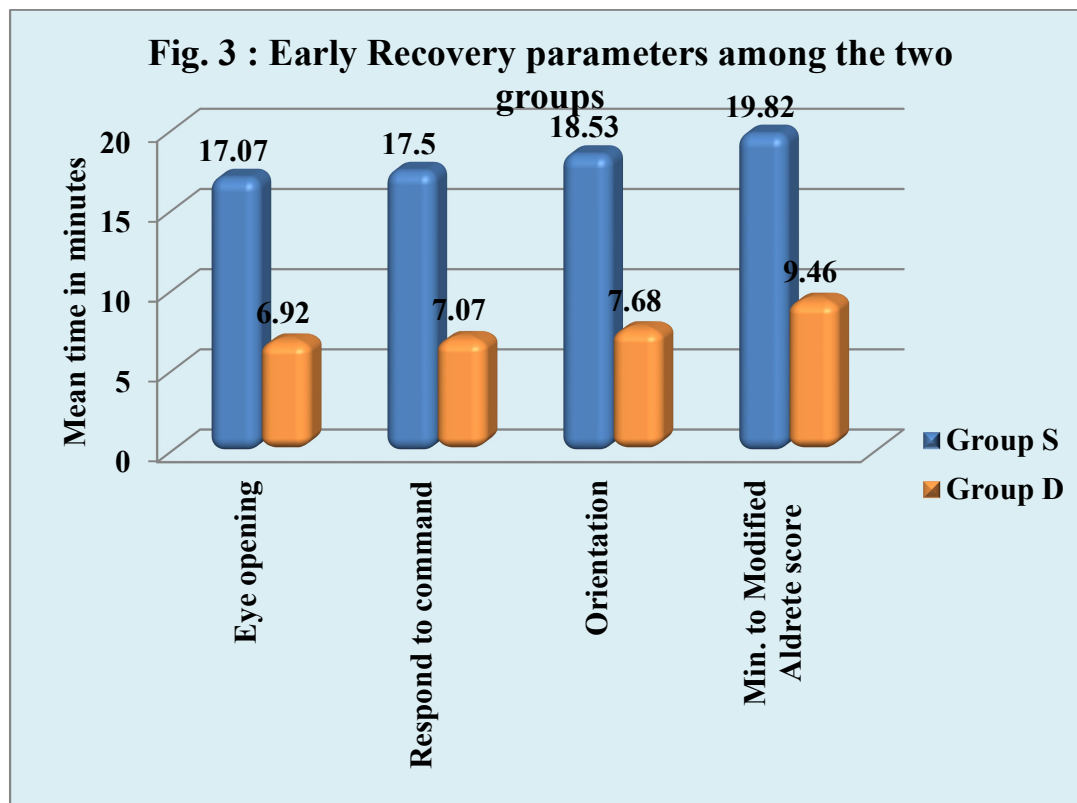
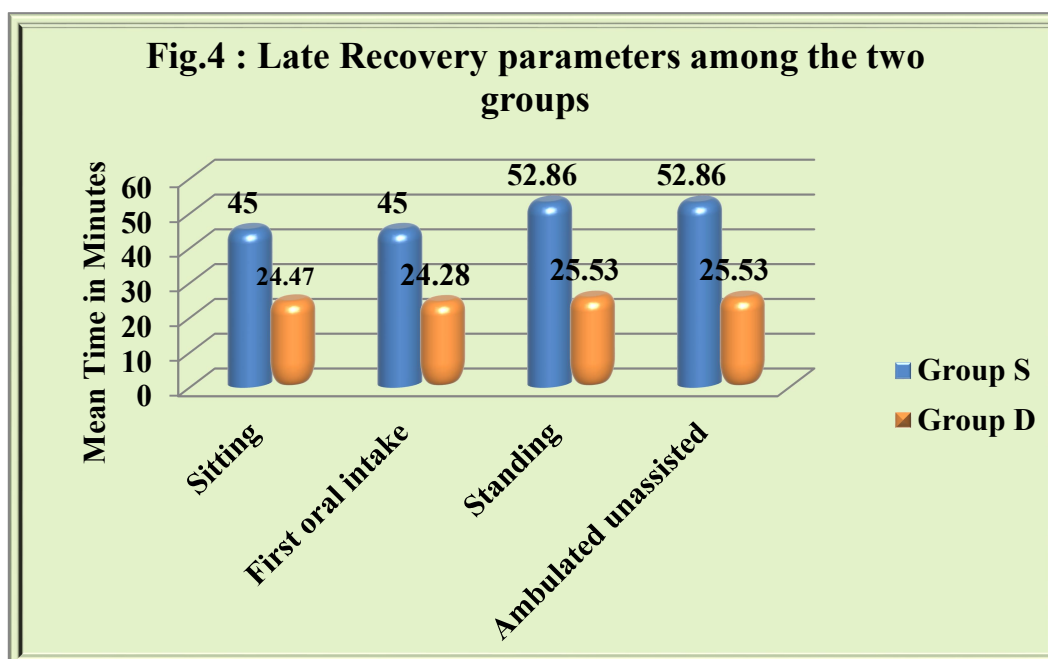


Table10: Late Recovery parameters among the two groups

Late recovery parameters	Group S (N= 28) Mean ± SD	Group D (N= 28) Mean ± SD	P value
Sitting	45.0±6.23	24.47±2.08	<0.001
First oral intake	45.0±6.23	24.28±2.24	<0.001
Standing	52.86±5.84	25.53±3.93	<0.001
Ambulated unassisted	52.86±5.84	25.53±3.93	<0.001



Demographic Variables -Both the groups are comparable in terms of Age, Sex, Height, Weight, BMI and ASA status with no statically significant difference seen(table 1)

Baseline Variables-Both groups are comparable in terms of baseline variables i.e., Heart rate, blood pressure, baseline oxygen saturation and respiratory rate with p value > 0.05 (table 2).

Hemodynamic Variables- The mean heart rate (MHR) varied from 84.32 to 90.00 beats/minute in the group which received Desflurane and from 84.00 to 85.67 beats/minute in the group which received Sevoflurane (Table 3, Figure1). The difference remains significant throughout the duration of surgery (p value< 0.05).

The mean arterial systolic blood pressure varied from 105.29 to 123.28mmHg in the group which received Desflurane and from 106.50to 125.67 mmHg in the group which received Sevoflurane (Table 4). There was no statistical difference in the mean arterial systolic blood pressure between the two groups. The mean arterial diastolic

blood pressure varied from 66.94 to 80.75 mmHg in the group which received Desflurane and from 67.50 to 80.25 mmHg in the group which received Sevoflurane (Table 5). There was no significant difference in diastolic blood pressure between two groups.

Respiratory Variables- No significant difference is observed in respiratory rate and spo₂ at induction, intraoperative and postoperatively among both the groups with the p value > 0.05 (Table 6 and Table 7).

Perioperative Airway Responses-

The incidence of respiratory complication like coughing was found only in group D as compared to group S. This difference was statistically significant. Other respiratory complications like breath holding and laryngospasm was not found in both the groups D and S (Table 8, Figure 2)

Early Recovery- Time taken to open the eyes, to obey the verbal commands and the time taken for orientation were shorter in the group D than the group S. The mean time taken to open the eyes was 6.92 minutes in the group D and 17.07 minutes in the group S (p value < 0.001).

The mean time taken to obey commands was 7.07 minutes in group D and 17.50 minutes in group S (p value < 0.001). The mean time taken for orientation was 7.68 minutes in group D and 18.53 minutes in group S (p value < 0.001) [Table 9, Figure 3].

Early recovery was shorter in the group D than the group S. Group D had a higher Aldrete score at the time of emergence in the OR. The mean time taken to achieve Modified Aldrete score 10 was 9.46 minutes in group D and 19.82 minutes in group S (p value < 0.001). Also after 10 minutes of arrival in the recovery, the time taken to reach an Aldrete score of 9 was lower in the group D.

Late Recovery-

Time taken to sit, to first oral intake, the time taken for standing and ambulate unassisted was shorter in the group which received Desflurane than the group which received Sevoflurane.

The mean time taken (after discontinuation of inhalation) to sit was 27.47 minutes in Desflurane group and 45 minutes in the Sevoflurane group (p value < 0.001). The mean time taken for first oral intake was 24.28 minutes in group D and 45 minutes in group S (p value < 0.001).

The mean time taken for standing was 25.53 minutes in group D and 52.86 minutes in the group S (p value < 0.001). The mean time taken to ambulate unassisted was 25.53 minutes in group D and 52.86 minutes in the group S (p value < 0.001) [Table 10, Figure 4]. Late recovery was shorter in the group D than the group S.

DISCUSSION

Laryngeal mask airway is effective for securing the airway in short surgical procedures. It minimizes the dead space, can be used without use of muscle relaxants and less stimulating than endotracheal tube. The time taken for placement is also usually less. The incidence of coughing and interruption of spontaneous breathing are much less.

Desflurane is a potent, inhaled anaesthetic. Low solubility of Desflurane (blood: gas partition is 0.42 - 0.46) in blood and body tissues facilitates a rapid induction of anaesthesia and precise control of depth of anaesthesia during maintenance. However its pungent odour and tendency to irritate the respiratory tract makes it unsuitable for induction of anaesthesia. It is also linked to sympathetic nervous system activation.

Sevoflurane, a volatile liquid for inhalation, is halogenated ether. It has rapid induction due to low blood: gas partition coefficient 0.63 - 0.69. It allows rapid inhalation induction, maintenance and rapid recovery. It has little toxicity and its haemodynamic and respiratory depressive effects. A total of 56 patients, ASA I and II, posted for elective superficial surgical procedure that satisfies the inclusion and exclusion criteria were enrolled in our study. They were equally divided in to two groups. All the demographic characteristics, ASA grading, baseline vital parameters were comparable in both the groups (p value > 0.05).

Initial rise in mean heart rate, seen in first 3 minutes, is under the effect of Desflurane Anaesthesia. Subsequently more rise in mean heart rate is seen in Group D, the difference being significant after 10 minutes of duration. The mean difference progressively increases as duration increases (p value < 0.05). These findings were consistent with the study by Arain SR et al⁽⁶⁾ which showed that Desflurane titration increases HR. This was unlike the findings of Jindal et al⁽⁷⁾ which showed no statistical difference in the intraoperative HR.

There was no statistical difference in the mean arterial systolic blood pressure and diastolic blood pressure between two groups. No significant difference is observed in respiratory rate at induction, intraoperative and postoperatively among both the groups. There was no statistical difference after induction up to the end of the procedure in SpO₂ between the groups.

1 patient had single emergent cough episode whereas 3 patients had multiple coughing episode at the time of emergence in Desflurane group. There was no coughing in any patient in Sevoflurane group. The result of our study are consistent with the result of Gildasio S. de Oliveria et al⁽⁸⁾ who also found that the overall incidence of coughing during perioperative period is more common in Desflurane group as compared to Sevoflurane group. This was unlike the findings of Ana Stevanovic et al⁽⁹⁾, Rachel Eshima McKay et al⁽¹⁰⁾ which found no difference in incidence of respiratory complications in the two groups.

In our study the time taken to open the eyes, to obey the verbal commands, the time taken for orientation and to achieve Modified Aldrete score 10 was shorter in the group which received Desflurane than the group which received Sevoflurane which is statistically significant (p value < 0.001). This was in accordance with the findings from previously published studies by Ana Stevanovic et al⁽⁹⁾, Jeong Min Kim et al⁽¹¹⁾, Ravi Jindal et al⁽⁷⁾

This finding of ours was different from that of other studies conducted by Gupta et al⁽¹²⁾, Karlson K Let al⁽¹³⁾, Larsen et al⁽¹⁴⁾, Behne Met al⁽¹⁵⁾.

In our study, the group D had a higher Aldrete score at the time of emergence in the OR. The mean time taken to achieve Modified Aldrete score 10 was 9.46 minutes in group D and 19.82 minutes in group S (p value < 0.001). Also after 10 minutes of arrival in the recovery, the time taken to reach an Aldrete score of 9 was lower in the group D.

This finding was similar to that of Jindal et al⁽⁷⁾, Earl M. Strum, MD et al⁽¹⁶⁾, Kudret Dogru MD et al⁽¹⁷⁾

[MAS (modified Aldrete score) >8 occurred significantly more rapidly in the Desflurane group than in the Sevoflurane group (p<0.001)] in studies like J. Dupont et al⁽¹⁸⁾, Song et al⁽¹⁹⁾ and Naidu-Sjosvard Ket al⁽²⁰⁾.

In our study the time taken to sit, to first oral intake, the time taken for standing and ambulate unassisted was shorter in the group D than the group S which is statistically significant (p value < 0.001). These findings are consistent with the studies done by McKay et al⁽²¹⁾, Rachel Eshima McKay et al⁽²²⁾, Cohen et al⁽²³⁾..

This finding of ours was different from that of other studies conducted by Macario A et al⁽²⁴⁾, Heavner et al⁽²⁵⁾, E. Michael Tarazi, MD et al⁽²⁶⁾.

CONCLUSION:

Laryngeal mask airway is effective for securing the airway in short surgical procedures. It can be used without use of muscle relaxants. Volatile anaesthetics are indispensable components of a balanced anaesthesia technique which are mainly used for the maintenance of anaesthesia. Desflurane is a relatively new potent inhalational agent that is widely used in both pediatric and adult anaesthesia, by virtue of its superior recovery profiles.

Sevoflurane is a widely used inhalational agent. It has low blood: gas partition coefficient used to provide rapid induction. Pharmacokinetic and pleasant odour of Sevoflurane makes induction feasible. Desflurane and Sevoflurane both afford smooth and rapid recovery from general anaesthesia. The intraoperative hemodynamic characteristics were comparable with both Desflurane and Sevoflurane. There was more incidence of coughing in the Desflurane group when compared to Sevoflurane group. Other respiratory events like breath holding and laryngospasm was not found in either group. The emergence (eye opening, obey the verbal commands, orientation and Modified Aldrete score 10) from anaesthesia was faster following the administration of Desflurane compared to Sevoflurane. In the group Desflurane, the Aldrete score was higher on arrival at the time of emergence. The time taken to reach an Aldrete score of 9 was lower in the group Desflurane. Recovery in PACU (post anaesthesia care unit) –that is sit, first oral intake, standing and ambulate unassisted were faster following the administration of Desflurane compared to Sevoflurane.

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