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Original Research Article

A comparative study of awakening characteristics after propofol based total intravenous anaesthesia and sevoflurane based volatile induction and maintenance anaesthesia in short surgical procedure

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ABSTRACT

Background: To maintain hemodynamic parameters and rapid emergence is a challenge for anaesthesiologist in emerging era of early recovery. The aim of this study was to assess recovery characteristics of propofol and sevoflurane for induction as well as maintenance of anaesthesia in short surgical procedures.

Materials and Methods: Sixty patients were assigned randomly into two groups. Group P patients were induced with 2mg/kg propofol intravenously followed by infusion of 12mg/kg/hr for 10mins, 10mg/kg/hr for 20 mins and 8mg/kg/hr till end of procedure. Group S patients were induced with 8% sevoflurane in 4L/min nitrous oxide and 2L/min oxygen mixture and maintained with 3.5% sevoflurane with spontaneous breathing. LMA was inserted in all patients. LMA insertion time and insertion attempt were observed. Time from end of procedure to first spontaneous movement, spontaneous eye opening, removal of LMA, followed verbal commands and became fully oriented to time and place, time to achieve Aldrete score ≥9 (phase I recovery) and time to achieve PADSS score ≥9(phase II recovery) were noted.

Results: Phase 1 recovery time was less in sevoflurane group as compared to propofol group. Phase 2 recovery time was less in propofol group as compared to sevoflurane group. They were statistically significant. Incidence of both nausea and vomiting was significantly higher in the sevoflurane group.

Conclusion: We concluded that sevoflurane provides rapid induction with LMA insertion condition comparable with propofol. Sevoflurane provides early phase I recovery where as home readiness is early with propofol. Sevoflurane can be a suitable alternative to propofol for induction and maintenance.

1. Introduction

A surgical procedure performed on a patient admitted and discharged on the same day of surgery is an accepted practice to make hospital resources available for a greater number of patients, as each patient gets discharged earlier from the hospital.[1] Rapid induction and recovery may lead to faster operating room turnover, shorter recovery room stay and earlier discharge to home.[2]

Propofol has low lipid solubility and it gets eliminated rapidly from circulation. Propofol is proven intravenous anaesthetic agent for day care procedures due to rapid onset of action with early recovery, less incidence of post operative nausea and vomiting. Sevoflurane is non-inflammable, highly fluorinated anaesthetic agent with pleasant smell. It is potent hypnotic and fairly non irritant to the upper airway.[3] Sevoflurane has low blood gas co-efficient and produces characteristics of fast induction and

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rapid emergence from anaesthesia.[3] Inhalational induction using sevoflurane is rapid, smooth and well tolerated in both children and adults.[4]

Having antiemetic property and rapid onset of action, propofol is being used for TIVA. Propofol based anaesthesia is associated with hypotension, bradycardia, pain on injection and may have allergic reaction.[5–7] Sevoflurane based anaesthesia provides relatively stable hemodynamics.[5] Many studies have been done for phase I recovery but not much work done on phase II recovery with respect to ready for discharge home criteria. So we conducted this study to compare recovery profile in both groups. Our primary goal was to assess and compare phase I - early recovery (time to achieve Aldrete score ≥ 9 in recovery room) as well as phase II – discharge to home recovery (time to achieve PADSS score ≥ 9) in both the groups. Our secondary goal was to assess and compare induction quality in terms of LMA insertion conditions in both the groups.

2. Material and Methods

2.1. Study design

This randomized prospective study was carried out after obtaining institutional ethical committee's approval. Study was done from January 2020 to September 2021. Study period was extended due to covid pandemic. Sixty patients undergoing short surgical procedure (lasting less than 30 minutes) in day care unit, belonging to ASA grade I or II, aged between 20 – 65 years, weighing less than 90 kg and with accompanying educated attendant who can understand and follow instructions were included.

Patients not willing, on sedative or opioid medication, pregnant patients, patients with h/o IHD, HTN, DM, allergy, respiratory or renal disease, psychiatric or neurological disease, susceptible to malignant hypertension, gastro-oesophageal reflux disease, airway MPG III and IV were excluded. We selected procedures in which muscle relaxant was not required. Patients were allocated randomly into two groups 30 patients in each. Group P - patients received propofol and group S - patients received sevoflurane for induction and maintenance of anaesthesia.

2.2. Study procedure

After taking informed written consent, pre anaesthetic check up was conducted with complete physical examination and airway assessment. Routine investigations were carried out. Preoperatively patients were kept nil by mouth from midnight prior to procedure because patients were planned in morning session and we were going to use LMA.

On arrival in the operating room, dragger fabius plus multipara monitor was applied for pulse oximetry (SpO_2), electro-cardiogram (ECG), non-invasive blood pressure (NIBP), end tidal CO_2 monitoring. Baseline values were recorded. Intravenous access was secured.

All the patients uniformly premedicated with intravenous inj. Glycopyrrolate 0.004mg/kg which is routinely used as antisialogogue if otherwise not contraindicated, inj. Ondansetron 0.01mg/kg, inj. Ranitidine 1mg/kg, inj. Fentanyl 2mcg/kg and antibiotic.

2.3. Method

2.3.1. Induction

Group - P (Propofol group): The patients had received 100% oxygen at 8L/min via face mask attached to Bain's (mapelson D) circuit for 3 min before induction. At the time of induction, fresh gas flow was changed to nitrous oxide 66% oxygen 33% at 6 L/min. Anaesthesia was induced with inj. Propofol 2mg/kg intravenously with 2% lidocaine 2 ml slowly over 30 secs till the loss of eyelash reflexes. If eyelash reflexes did not abolish, additional dose of propofol was given in 20mg increment.

Group - S (Sevoflurane group): The patients had received 100% oxygen at 8L/min via face mask attached to Bain's (mapelson D) circuit for 3 min before induction. Circuit was primed with sevoflurane 8% and O_2 8L/min for 30 seconds. Anaesthesia was induced with sevoflurane 8% and 66% nitrous oxide in 33% oxygen (Drager ASCF-0168 GmbH Lubeck, Germany). Patients were asked to inhale and exhale maximally through mask at induction till the loss of eyelash reflexes. Loss of eyelash reflex was considered as the end point of induction in both the groups.

2.4. LMA insertion in both groups

Laryngeal mask airway placement was attempted by senior resident when eyelash reflexes abolished. LMA size 3 for female patient and LMA size 4 for male patient was used. No muscle relaxant was used. The cuff was inflated with the recommended volume of air (20ml air in size 3 and 30ml air in size 4). Verification of position of LMA was done by absence of audible leak with positive ventilation with Bag-Valve Mask device and capnography. The patients were ventilated while confirming equal breath sounds over both lungs in all fields and the absence of ventilatory sounds over the epigastrium.

In case of unsuccessful LMA insertion, additional dose of propofol 20mg bolus was given in propofol group and continuous spontaneous, assisted ventilation of sevoflurane 8% in 66% nitrous oxide in 33% oxygen in sevoflurane group till loss of eyelash reflex. If third attempt was required, patient was removed from the study.

Attempt for LMA insertion, time taken for LMA insertion (time from induction to successful airway placement) and insertion conditions were observed in terms of jaw relaxation, head and limb movement, coughing and gagging.

2.5. Maintenance

2.5.1. Propofol group

Patient received continuous infusion of propofol from a syringe pump (Braun Melsungen 'S' series). Propofol concentration was 10mg/ml in 50ml syringe. Infusion rate was adjusted according to the following regimen:

1. 12 mg/kg/h for 10min
2. 10 mg/kg/h for 20 min
3. 8 mg/kg/h till the end of procedure

Propofol infusion was adjusted to achieve absence of purposeful movements and maintain mean arterial pressure and heart rate values within 15% of the pre-induction baseline values. If this was not maintained, additional bolus dose of propofol 20mg was given. All the patients were breathing spontaneously with fresh gas flow of 66% nitrous oxide and 33% oxygen throughout the procedure. Hypotension was managed with iv fluids. Inj. atropine 0.3 mg iv given if heart rate falls 20% of baseline value.

2.5.2. Sevoflurane group

Patients were allowed to breathe spontaneously with 3.5% sevoflurane with fresh gas flow of 66% nitrous oxide and 33% oxygen to achieve absence of purposeful movements and maintain mean arterial pressure and heart rate values within 15% of the pre-induction baseline values. If this was not maintained, sevoflurane was titrated with 0.5% increment or decrement according to hemodynamic. MAC monitoring was done for sevoflurane group.

Electrocardiogram, pulse rate, non-invasive blood pressure and oxygen saturation (SpO_2) were monitored. At the end of procedure, study drug was stopped and 100% oxygen was given. This time was taken as time 'zero' to calculate the recovery time. When patient was able to follow verbal commands, LMA was removed. Emergence events such as coughing, breath holding were noted.

Pulse rate (PR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP), end tidal CO_2($ETCO_2$) and oxygen saturation(SpO_2) were recorded at baseline, during induction, during LMA insertion, every 5 minute till end of the procedure, during removal of LMA and every 5min till the patient was shifted to recovery room. All the necessary parameters for assessment of phase I and phase II recovery were included. Time interval were recorded in minutes from end of study drug to spontaneous eye opening, removal of LMA, patient followed verbal commands and patient became fully oriented to time and place. In recovery room, time to achieve Aldrete score $\geq$ 9(phase I recovery) and time to achieve PADSS score $\geq$ 9(phase II recovery) was noted.[8] Incidence of nausea and vomiting, time to achieve steady gait and time for first oral liquid was noted (for assessment of phase II recovery).

2.6. Statistical analysis

The statistical analysis was carried out using SPSS Inc., Chicago, IL, USA, version 19.0 for Windows. Parametric data were analyzed using paired and un-paired t-tests. Qualitative or categorical variables were compared using Chi-square test or Fisher's exact test. All statistical tests were two sided and were performed at a significance level of α = 0.05. Results of continuous measurements were presented as Mean ± SD and results of categorical measurements were presented in number and percentage (%). P value $\leq$ 0.05 was considered as significant. Sample size was calculated on the basis of time to response to verbal commands in propofol group; mean 5.3±2.9 minutes and in sevoflurane group; mean 8±2.9 minutes as per previous study.[9] Sample size was calculated by using 90% of power, confidence level 95% and 5% α value(type I error). Therefore, we needed 30 patients in each group.

3. Observations and Results

We included 60 adult patients and randomly assigned into two groups of 30 patients in each group.

As shown in Table 1 both the groups were comparable with respect to age, sex, height, weight and mean duration of surgery. There was no statistical difference between them. Distribution of surgical procedures were similar in both the groups. We included breast biopsy, cystoscopy, resuturing and bone biopsy.

As shown in Table 2 significantly less time was taken for LMA insertion in propofol group as compared to sevoflurane group. LMA insertion in 1^{st}attempt was higher in propofol group but was not statistically significant. Gag was reported in 3 patients in propofol group and in 4 patients in sevoflurane group. Coughing was present in 2 patients in propofol group and in 1 patient in sevoflurane group. The difference was not statistically significant. Second attempt was required for LMA insertion in 9 patients in propofol group and 13 patients in sevoflurane group.

As shown in Table 3 time to eye opening, following verbal commands, removal of LMA and fully oriented to time, place and person were significantly shorter in sevoflurane group. Incidence of coughing was present in 12 patients in sevoflurane group and 8 patients in propofol group. The difference was statistically insignificant.

Time to achieve steady gait was significantly shorter (29.1±3.32 min) in propofol group as compared to sevoflurane group (41.97±4.13 min). Time to get first oral meal was significantly shorter (40.06±3.59 min) in propofol group as compared to (53.97±2.75 min) in sevoflurane group. Incidence of nausea and vomiting was significantly higher in sevoflurane group (60%) as compared to propofol group (23%).

Significantly less time was taken in sevoflurane group as compared to propofol group to achieve Aldrete score

Table 1: Demographic data in both groups

Variables	Group P Mean ± SD	Group S Mean ± SD	P Value
Age (years)	44.8±10.17	42.63±11.42	0.4402
Sex(M:F)	10:20	7:23	-
Height (cm)	153.93±6.43	156.17±6.87	0.1986
Weight (kg)	51.26±10.53	50.67±8.40	0.8291
Duration of surgery(min)	27.1±2.88	25.27±5.59	0.0691

Data expressed as Mean ± SD, P value < 0.05 was considered significant

Table 2: Comparison of LMA insertion condition in both the groups

Variables	Group P Mean± SD	Group S Mean± SD	P value
Time taken for LMA insertion (min)	1.31±0.43	2.19±0.37	0.0001
Attempt for LMA insertion	1^{st} attempt: 21(70%)	1^{st} attempt: 17(57%)	0.4215
	2^{nd}attempt: 9(30%)	2^{nd}attempt: 13(43%)	0.4215
Head Movement	4(13.33%)	4(13.33%)	1.000
Limb Movement	5(16.67%)	6(20%)	1.000
Gag	3(10%)	4(13.33%)	1.000
Cough	2(6.67%)	1(3.33%)	1.000
Laryngospasm	0	0	-

Data expressed as Mean ± SD, P value <0.05 was considered significant

Table 3: Comparison of early recovery and adverse emergence events in both the groups

Variables	Group P Mean± SD	Group S Mean± SD	P value
Eye opening (min)	9.27±1.22	7.23±0.77	0.0001
Followed verbal commands (min)	9.57±1.22	7.67±0.76	0.0001
Removal of LMA (min)	10.13±1.17	9.13±0.97	0.0006
Full orientation (min)	11.03±1.13	9.77±1.14	0.0001
Coughing	8(26.67%)	12(40%)	0.4111
Breath holding	2(6.67%)	4(13.33%)	0.6671

Data expressed as Mean ± SD, P value <0.05 significant

Table 4: Recovery score in both the groups

Time taken to achieve	Group P Mean± SD	Group S Mean± SD	P value
ALDRETE Score ≥9	31.67±2.33	23.83±2.91	0.0001
PADSS Score ≥9	52.03±4.30	60.57±3.92	0.0001

Data expressed as Mean± SD, P value <0.05 was considered significant

≥9. Significantly less time was taken in propofol group as compared to sevoflurane group to achieve PADSS score ≥9.

4. Discussion

A day care procedure is undertaken with admission, operation and discharge home on the same day.Intravenous agents are used commonly for induction of anaesthesia followed by inhalational agents for maintenance. This technique has the transition phase from the time of induction to maintenance.[10] The rapid redistribution of the intravenous agent could lead to lightening of anaesthesia before an adequate depth is achieved with the inhalational agent. This has promoted the discovery of 'single agent' anaesthesia which decreases problems associated with transition phase.[11]

J. W. Sear et al[12] studied manual stepped infusions of propofol according to patient's weight. They found that it had produced adequate plasma propofol levels and uneventful surgery could be carried out. We also used stepped infusion in our study.

K. R. Watson et al[13] conducted study for TIVA using propofol for induction and maintenance by target-controlled infusion of propofol with air and oxygen. Sevoflurane induction was done using face mask and circle system starting at 8% sevoflurane during induction and during maintenance 67% nitrous oxide in 33% oxygen with up to 3.5% sevoflurane. They found time to loss of consciousness with propofol (66.7sec) was significantly shorter than sevoflurane (96.9sec). J. K. Moore et al[14] reported induction time between 109 to 186 sec with sevoflurane. This may be because of limitation of vaporiser. They were using vaporiser which allowed maximum 5% sevoflurane and

0.5% increment. Study done by A. Thwaites et al[15] had reported rapid induction of 84sec with starting 8% sevoflurane-nitrous oxide. We also induced patient with 8% sevoflurane-nitrous oxide and found rapid achievement of acceptable LMA insertion condition (130 sec).

The use of 66% nitrous oxide has additive effect and thereby reduces the MAC of sevoflurane by up to 60%, thus decreasing the amount required to maintain anaesthesia. J. A. Davidson et al[16] observed that it is possible that nitrous oxide has a similar effect on propofol, being attributed to decrease EC_{50} (the effective concentration at which 50% of patients do not respond to a painful stimuli) by approximately 30%. Thus, adding nitrous oxide could reduce the maintenance dose of propofol. We added similar concentration of nitrous oxide in both the groups.

Jun Tang et al[2] conducted study to compare induction and maintenance with propofol-nitrous oxide and sevoflurane–nitrous oxide. They observed that eye opening time was 6±2min in propofol group and 5±2min in sevoflurane group, time to response to verbal commands was at 6±2 min in propofol group and at 5±2 min in sevoflurane group, full orientation was at 6±2min in propofol group and at 5±2min in sevoflurane group. All times were shorter in sevoflurane group. Similar to this K. R. Watson[13] also observed time to eye opening, time to extubation and concluded that emergence time and early recovery characteristics were unaffected by the anaesthesia technique. Similarly in our study, we found time to eye opening was shorter in sevoflurane group (7.23±0.77 min) as compared to propofol group (9.27±1.22 min). Patients followed verbal commands at 9.57±1.22min in propofol group whereas at 7.67±0.76min in sevoflurane group. Full orientation was achieved at 11.03±1.13min in propofol group and at 9.77±1.14min in sevoflurane group. A Thwaites et al[15] also found emergence was earlier in patients induced with sevoflurane (5.2 ± 2.2min) as compared to induced with propofol (7.0±3.2min).

A. A. Kumar et al[17] studied recovery profile after propofol and sevoflurane anaesthesia. They compared phase I recovery (Aldrete score) and phase II recovery (PADSS score) after both the agents. They observed that time to achieve Aldrete score ≥ 9 has no significant difference between the groups. Time to achieve PADSS score ≥ 9 was significantly earlier in sevoflurane group (30.7 ± 8.78 min) as compared to propofol group (56±22.6min). R. Lohia et al[11] done comparison of recovery profile after sevoflurane and propofol based induction and maintenance in day care surgery and found that propofol-N2O was associated with an improved recovery profile and greater patient satisfaction as compared to sevoflurane-N2O anaesthesia.

In our study we observed that time to achieve Aldrete score ≥ 9 was significantly earlier in sevoflurane group (23.83±2.91min) as compared to propofol group (31.67±2.33min). While time to achieve PADSS score ≥ 9 was earlier in propofol group (52.03 ± 4.30min) as compared to sevoflurane group (60.57±3.92 min).

J. K. Moore et al[14] studied adverse emergence events in 322 patients and observed more incidence of cough with propofol group (11 patients) as compared to sevoflurane group (9 patients) which was not statistically significant, incidence of breath holding in 2 patients and laryngospasm in 4 patients were noted in sevoflurane group. In our study we found higher incidence of coughing and breath holding in sevoflurane group as compared to propofol group.

Other studies[11,14,18] found that post operative nausea and vomiting was less in propofol group as compared to sevoflurane group in recovery room. Similar to this, we observed post operative nausea and vomiting significantly less in the propofol group (23.3%).

5. Limitation

Bis monitoring was not done due to unavailability of monitor at our institute.

6. Conclusion

We concluded that early recovery time was lesser in sevoflurane group while late recovery time was lesser in propofol group. Sevoflurane can be a suitable alternative to propofol for induction and maintenance of anaesthesia.

7. Source of Funding

None.

8. Conflict of Interest

The authors declare no conflict of interest.

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