Indian Journal of Clinical Anaesthesia 2021;8(1):68–73

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Clinical Anaesthesia

Journal homepage: www.ijca.in

Original Research Article

Recovery from desflurane and sevoflurane anaesthesia after prolonged surgery - A comparative study using Index of Consciousness (IoC) monitoring

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ARTICLE INFO

Article history:
Received 28-09-2020
Accepted 04-11-2020
Available online 15-03-2021

Keywords:
Depth of anaesthesia
Desflurane
Index of Conciousness
Sevoflurane

ABSTRACT

Background: The present study compared the recovery from desflurane and sevoflurane anaesthesia in patients after prolonged surgery using Index of Consciousness (IoC) monitoring scale.
Materials and Methods: A total of 50 patients between 18 to 60 years of age, scheduled to undergo prolonged surgeries (lasting for more than 120 minutes) were included in this study and randomly divided in two groups (Group A: Desflurane; Group B: Sevoflurane) of 25 patients each.
Results: The patients who received Desflurane had better recovery characteristics than Sevoflurane. Results showed that for attaining value of IoC- 95, mean time required by patients of group A was 1.82 (± 0.50) minutes as compared to 5.36 (± 0.95) minutes by group B. Similarly for attaining value of IoC-99 (i.e. state of complete consciousness), mean time required by patients of group A was 11.04 (± 1.62) minutes as compared to 22.84 (± 4.85) minutes by group B. The results were significantly different ($p< 0.05$) for both the values of IoC.
Conclusion: The present study concludes that inhalation based desflurane anaesthesia has a faster recovery than sevoflurane anaesthesia in prolonged surgeries, when both are guided by IoC monitoring.

1. Introduction

There is an ongoing quest to know which agent is most suitable for induction as well as maintenance of anaesthesia. Agents which show excellent induction and maintenance characteristics may not necessarily provide ideal recovery profile.

Achieving adequate depth of anaesthesia during surgical procedure is desirable. Assessment of depth of anaesthesia is fundamental to anaesthesia practice. While deep level of anaesthesia, resulting in cardiovascular depression and prolonged awakening is of clinical significance, light anaesthesia is more frightening for the patient. Awareness during anaesthesia can lead to long-term effects such as anxiety, nightmares, flashbacks, clinical depression and post-traumatic stress disorder. There are various subjective and objective methods of assessing depth of anesthesia. Subjective methods rely on the movement and autonomic response to stimuli and depend on the opinion and experience of an anesthetist. The objective methods rely on the sensitivity of the monitor. The Index of Consciousness (IoC) monitor is one such device. The main parameter of the IoC is the symbolic dynamics method, which detects the complex non-linear properties of the EEG that can be correlated to the depth of anaesthesia. [1]

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https://doi.org/10.18231/j.ijca.2021.013

Desflurane is known to have a rapid onset and offset of action, thereby making it possible for the anesthesiologist to control the depth of anaesthesia rapidly. It also provides haemodynamic stability with preservation of tissue perfusion even in face of hypotension;[2] however it is irritating to the airway and therefore is not routinely utilised for inhalational induction.[2,3] However, studies have shown that controlled desflurane induction along with opioid premedication can be rapid and well tolerated.[4,5] Sevoflurane administration has been associated with a smooth, rapid loss of consciousness during inhalation induction and a rapid recovery following discontinuation of anaesthesia. The present study was carried out to assess the recovery from Desflurane and Sevoflurane anaesthesia after prolonged surgery using Index of Consciousness (IoC) monitoring scale.

2. Materials and Methods

This was a prospective randomized comparative study. After approval from institutional ethics committee and obtaining written informed consent, fifty adults of either sex between the age group of 18 and 60 years, belonging to the American Society of Anaesthesiologists physical status I and II, scheduled to undergo prolonged surgeries (lasting for more than 120 minutes; primarily Gastrointestinal, Oncologic, Maxillofacial, Otolaryngeal and Neurological surgeries) were enrolled in the study. Patients with significant co-morbities (coronary artery disease, chronic pulmonary disease, renal failure, hepatic dysfunction, severe anemia), obese patients (BMI >35kg/m2), and those with exposure to general anesthetic agents within previous seven days were excluded from the study. The patients were randomly divided into two groups of 25 each, to receive either Desflurane/Nitrous oxide (Group A) or Sevoflurane/Nitrous oxide anaesthesia (Group B).

Patients were administered 2mcg kg-1 fentanyl and anaesthesia was induced with Propofol 1.5-2.5 mg kg-1 intravenous. The neuromuscular blockade was provided with vecuronium 0.1mg/kg. Anaesthesia was maintained with either Desflurane 2-6% or Sevoflurane 0.6-1.75% with Nitrous oxide 65% in Oxygen and intermittent doses of Vecuronium. Inspired anaesthetic concentrations were adjusted to obtain adequate surgical anaesthesia (IoC value between 40-50) and fentanyl was repeated as per requirement at the discretion of the attending anaesthesiologist to maintain mean arterial pressure within 20% of baseline values. Mechanical ventilation was adjusted to keep the end tidal CO_2 concentration between 35 to 38 mm Hg. Lactated Ringers solution was used for correction of fluid deficit and for maintenance requirements during surgery.

The volatile anaesthetic agents were cut-off at the time of last skin suture and time taken for attainment of the Index of Consciousness index to 95 and 99 during recovery period using the Morpheus Medicals IoC view monitor was noted. The individual value of IoC scores thus obtained was tabulated for Desflurane and Sevoflurane separately.

Monitoring during anaesthesia consisted of continuous ECG, heart rate, pulse oximetry, side stream capnometry, non-invasive blood pressure, nasopharyngeal temperature and Index of consciousness (Ioc). All parameters were recorded at 15 min. intervals. Neuromuscular block was antagonized with Glycopyrrolate (6-8mcg kg-1 IV) and Neostigmine (40-80 mcg kg-1 IV). Ventilation of lungs was continued with oxygen 100% at a fresh gas flow rate of 6 litre min-1 until the patient was extubated.

2.1. IoC-view scale

The IoC-view is a continuous processed EEG parameter that correlates to the patient's level of hypnosis where decreasing IoC-view values correspond to gradually loss of consciousness and a deepening of the level of anaesthesia. In a scale from 99 to 0, an index of 99 indicates an awake patient and an index of 0 indicates a flat EEG.

2.2. Statistical analysis

Data were statistically described in terms of mean (±SD), frequencies (number of cases) and percentages when appropriate. Data was tested first for normal distribution by Klomogorov– Smirnov test. Comparison of quantitative variables between the study groups was done using student t test for independent samples, when variables were found to be normally distributed. For comparing categorical data, Chi square test was performed. Exact test was used instead when the expected frequency is less than 5. A probability value (p value) less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs Microsoft Excel 2007 (Microsoft Corporation, NY, USA) and SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15.

3. Results

A total of fifty patients enrolled and completed the study. The demographic characteristics such as mean age and sex were comparable in the two groups. The mean age of group A patients was 46.4 (± 12.2) years while mean age of Group B patients was 43.6 (± 12.4) years (Table 1). The mean age difference was statistically not significant (p>0.05). Group A consisted of 72% female patients while 52% of patients in group B were females (Table 2). There was no significant difference in the two groups regarding sex distribution (p> 0.05).

3.1. Intraoperative hemodynamics

Heart rate (HR) and non-invasive blood pressure (NIBP) of the patients were recorded at 15 min. intervals during the

Table 1: Age wise distribution of study groups

Age (years)	Desflurane	Sevoflurane	t-value	p-value
Mean	46.4	43.6		
SD	12.2	12.4	0.79	0.43
SEM	2.4	2.5		

Table 2: Sex wise distribution of study groups

Study Group		Desflurane		Sevoflurane		p-value
			%		%	
Sex	Male	7	28	12	48	0.24
	Female	18	72	13	52	

surgery. In our study mean HR from 0 min to 180 min was higher with desflurane in comparison to sevoflurane group (Table 3), though the difference was significant in few readings only (at 75,105 and 135 min.). No significant difference was noted in mean NIBP (systolic and diastolic) from 0 min to 180 min in both the study groups (Table 4 and Table 5).

3.2. IoC value

The inspired anaesthetic concentration was adjusted to obtain adequate surgical anaesthesia. IoC value throughout surgery ranged from 40-50 in patients of both groups (Table 6). The time taken for attainment of the Index of Consciousness index to 95 and 99 during recovery period using the IoC view monitor was noted. It was observed that for attaining value of IoC- 95, mean time required by patients of group A was 1.82 (± 0.5) minutes as compared to 5.36 (± 0.95) minutes by group B. Similarly for attaining value of IoC-99, mean time required by patients of group A was 11.04 (± 1.62) minutes as compared to 22.84 (± 4.85) minutes by group B. There was a significant difference among both groups as per time required for recovery, with patients of group A demonstrating significantly faster recovery ($p< 0.05$) than patients of group B (Table 7).

4. Discussion

Sevoflurane and desflurane have pharmacokinetic properties that favour rapid emergence from anaesthesia. More rapid recovery from prolonged anaesthesia may be an advantage in the elderly in whom cognitive impairment (e.g. delirium, confusion) is a problem during recovery.[6]

Desflurane produces greater sympathetic stimulation. Thus, at concentration above 1 MAC, steady state concentration of desflurane produces a dose-related increase in heart rate.[7] The heart rate in our study was higher in desflurane group across majority of the time intervals.

Sevoflurane is a dose-related cardiac depressant. Increasing concentrations of sevoflurane progressively decrease blood pressure in a manner similar to the other volatile anaesthetics, and in unstimulated volunteers this decrease may be slightly less than with isoflurane at a higher MAC. Sevoflurane decreases myocardial contractility in a manner similar to equianaesthetic concentrations of isoflurane and desflurane, and does not potentiate epinephrine-induced cardiac arrhythmias.[8] No significant difference for NIBP was observed in the two groups of our study.

The availability of less soluble inhalation anesthetics such as sevoflurane and desflurane has led to a reassessment of the use of volatile anesthetics for rapid recovery after surgery. Given the low blood-gas partition coefficients of sevoflurane (0.69) and desflurane (0.42), a more rapid emergence from anaesthesia is expected compared with traditional inhalation anesthetics. Not surprisingly, both drugs have shorter emergence times compared to isoflurane based techniques. The recovery from anaesthesia in patients of both groups was compared using IoC monitoring scale, which has been validated in various studies.[9–11] There was a significant difference among both groups of our study as per time required for recovery, with patients of desflurane group demonstrating significantly faster recovery than sevoflurane group. Our results correlated well with those of Heavner et al., who compared emergence from desflurane vs sevoflurane in elderly patients undergoing two or more hours of anaesthesia. They observed that times required to extubation, eye opening and orientation were significantly less for desflurane.[12] In a similar study in paediatric population, Welborn et al compared the emergence and recovery characteristics of sevoflurane, desflurane, and halothane in children undergoing adenoidectomy with bilateral myringotomy and the insertion of tubes. The authors concluded that emergence and recovery from anaesthesia was significantly faster in the desflurane group compared with the sevoflurane and halothane groups.[13] Chen et al. evaluated the cognitive recovery profiles in elderly patients after general anaesthesia with desflurane or sevoflurane, and inferred that the use of desflurane was associated with a more rapid emergence from anaesthesia and a shorter length of stay in the postanesthesia care unit.[14] A meta-analysis of trials comparing postoperative recovery after anaesthesia with sevoflurane or desflurane done by

Table 3: Comparison among study groups as per Heart rate

Heart Rate (per min.)	Group	N	Mean	SD	SEM	t-value	P-value
15 Min.	Desflurane	25	72.40	7.94	1.59	0.36	0.72
	Sevoflurane	25	71.60	7.51	1.50		
30 Min.	Desflurane	25	70.08	7.80	1.56	0.16	0.87
	Sevoflurane	25	70.48	9.10	1.82		
45 Min.	Desflurane	25	70.20	6.87	1.37	0.78	0.44
	Sevoflurane	25	68.40	9.24	1.85		
60 Min.	Desflurane	25	70.08	7.34	1.47	1.59	0.12
	Sevoflurane	25	66.32	9.28	1.86		
75 Min.	Desflurane	25	71.76	7.47	1.49	2.32	0.03
	Sevoflurane	25	66.24	9.27	1.85		
90 Min.	Desflurane	25	69.40	7.25	1.45	1.19	0.24
	Sevoflurane	25	66.52	9.75	1.95		
105 Min.	Desflurane	25	69.88	8.35	1.67	2.10	0.04
	Sevoflurane	25	64.80	8.85	1.77		
120 Min.	Desflurane	25	68.56	8.44	1.69	0.99	0.32
	Sevoflurane	25	66.00	9.70	1.94		
135 Min.	Desflurane	23	69.74	8.07	1.68	2.24	0.03
	Sevoflurane	22	64.27	8.42	1.80		
150 Min.	Desflurane	18	66.33	4.81	1.13	1.78	0.09
	Sevoflurane	17	62.29	8.29	2.01		
165 Min.	Desflurane	8	67.50	1.41	0.50	0.59	0.56
	Sevoflurane	9	65.22	10.77	3.59		
180 Min.	Desflurane	6	65.67	4.97	2.03	0.79	0.45
	Sevoflurane	3	68.67	6.11	3.53		

Table 4: Comparison among study groups as per NIBP (Systolic)

Systolic B.P (mm Hg)	Group	N	Mean	SD	SEM	t-value	P-value
15 Min.	Desflurane	25	125.12	7.42	1.48	0.48	0.63
	Sevoflurane	25	126.08	6.74	1.35		
30 Min.	Desflurane	25	119.68	8.14	1.63	0.03	0.97
	Sevoflurane	25	119.76	8.31	1.66		
45 Min.	Desflurane	25	114.56	8.50	1.70	0.28	0.78
	Sevoflurane	25	113.92	7.67	1.53		
60 Min.	Desflurane	25	115.52	6.36	1.27	0.04	0.96
	Sevoflurane	25	115.44	6.23	1.25		
75 Min.	Desflurane	25	116.08	9.30	1.86	0.98	0.32
	Sevoflurane	25	118.32	6.47	1.29		
90 Min.	Desflurane	25	114.45	6.41	1.28	0.91	0.31
	Sevoflurane	25	116.67	6.94	1.38		
105 Min.	Desflurane	25	113.78	7.14	1.46	0.34	0.81
	Sevoflurane	25	114.48	6.31	1.26		
120 Min.	Desflurane	25	115.61	7.50	1.52	0.03	0.97
	Sevoflurane	25	115.81	6.48	1.29		
135 Min.	Desflurane	23	114.56	7.96	1.58	0.02	0.98
	Sevoflurane	22	114.45	8.23	1.65		
150 Min.	Desflurane	18	115.9	8.98	1.81	0.38	0.75
	Sevoflurane	17	113.92	7.42	1.54		
165 Min.	Desflurane	8	115.12	7.36	1.53	0.31	0.76
	Sevoflurane	9	114.42	6.83	1.31		
180 Min.	Desflurane	6	114.98	8.35	1.66	0.08	0.94
	Sevoflurane	3	115.18	7.45	1.54		

Table 5: Comparison among study groups as per NIBP (Diastolic)

Diastolic B.P (mm Hg)	Group	N	Mean	SD	SEM	t-value	P-value
15 Min.	Desflurane	25	71.52	6.64	1.33	0.04	0.97
	Sevoflurane	25	71.60	8.64	1.73		
30 Min.	Desflurane	25	66.72	6.43	1.29	0.41	0.68
	Sevoflurane	25	67.60	8.52	1.70		
45 Min.	Desflurane	25	63.60	7.33	1.47	0.00	1.00
	Sevoflurane	25	63.60	7.19	1.44		
60 Min.	Desflurane	25	62.40	7.68	1.54	0.92	
	Sevoflurane	25	60.32	8.30	1.66		
75 Min.	Desflurane	25	64.24	8.70	1.74	0.32	0.72
	Sevoflurane	25	65.04	8.53	1.71		
90 Min.	Desflurane	25	70.42	6.69	1.33	0.86	0.44
	Sevoflurane	25	68.64	7.78	1.70		
105 Min.	Desflurane	25	67.78	7.32	1.68	0.56	0.58
	Sevoflurane	25	66.61	7.52	1.69		
120 Min.	Desflurane	25	64.89	7.73	1.70	0.11	0.87
	Sevoflurane	25	65.12	7.29	1.46		
135 Min.	Desflurane	23	61.98	7.58	1.55	0.33	0.71
	Sevoflurane	22	62.78	7.56	1.54		
150 Min.	Desflurane	18	64.78	8.79	1.72	0.24	0.81
	Sevoflurane	17	65.14	8.12	1.68		
165 Min.	Desflurane	8	62.67	7.78	1.55	0.57	0.52
	Sevoflurane	9	61.37	8.45	1.74		
180 Min.	Desflurane	6	64.94	7.76	1.70	0.21	0.83
	Sevoflurane	3	64.23	7.58	1.52		

Table 6: Comparison among study groups as per IoC value during surgery

IoC Value	Group	N	Mean	SD	SEM	t-value	P-value
15 Min.	Desflurane	25	44.76	3.19	0.64	1.65	0.11
	Sevoflurane	25	46.20	2.99	0.60		
30 Min.	Desflurane	25	47.04	3.14	0.63	0.66	0.51
	Sevoflurane	25	46.36	4.10	0.82		
45 Min.	Desflurane	25	46.00	5.37	1.07	0.89	0.37
	Sevoflurane	25	47.40	5.69	1.14		
60 Min.	Desflurane	25	45.04	4.68	0.94	0.03	0.97
	Sevoflurane	25	45.08	4.10	0.82		
75 Min.	Desflurane	25	45.60	2.96	0.59	0.90	0.37
	Sevoflurane	25	44.76	3.60	0.72		
90 Min.	Desflurane	25	44.84	3.59	0.72	0.12	0.91
	Sevoflurane	25	44.96	3.76	0.75		
105 Min.	Desflurane	25	46.56	3.49	0.70	1.76	0.08
	Sevoflurane	25	44.52	4.62	0.92		
120 Min.	Desflurane	25	46.04	3.86	0.77	0.36	0.71
	Sevoflurane	25	45.60	4.56	0.91		
135 Min.	Desflurane	23	47.22	4.10	0.86	2.29	0.03
	Sevoflurane	22	44.55	3.67	0.78		
150 Min.	Desflurane	18	46.56	3.88	0.92	1.36	0.18
	Sevoflurane	17	44.69	4.14	1.04		
165 Min.	Desflurane	8	44.25	4.20	1.49	0.93	0.37
	Sevoflurane	9	46.10	4.23	1.34		
180 Min.	Desflurane	6	47.67	1.97	0.80	1.14	0.29
	Sevoflurane	3	49.33	2.31	1.33		

Table 7: Comparison among study groups as per IoC value after surgery

IoC Value	Group	N	Mean (min.)	SD	SEM	t-value	P-value
Ioc 95	Desflurane	25	1.82	0.50	0.10	16.47	< 0.001
	Sevoflurane	25	5.36	0.95	0.19		
Ioc 99	Desflurane	25	11.04	1.62	0.32	11.53	< 0.001
	Sevoflurane	25	22.84	4.85	0.97		

Macario et al showed that patients receiving desflurane recovered 1–2 minutes quicker in the operating room than patients receiving sevoflurane.[15]

The limitation of our study is that the study design did not permit a double-blind comparison of the two inhalational anaesthetics. However, similar depth of anaesthesia was maintained with both volatile anaesthetics until the end of surgery to enable assessment of recovery from similar clinical end-points. Furthermore, the observers performing the recovery assessments were blinded.

5. Conclusion

The use of desflurane for maintenance of anaesthesia resulted in faster postoperative recovery, as compared to sevoflurane, in patients undergoing prolonged surgeries; while no significant difference was observed in NIBP, oxygen saturation, end tidal CO_2 and nasopharyngeal temperature.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Choubey RK, Bhushan K, Singh G, Kulkarni SN, Honwad M, Yadav R. Recovery from desflurane and sevoflurane anaesthesia after prolonged surgery - A comparative study using Index of Consciousness (IoC) monitoring. *Indian J Clin Anaesth* 2021;8(1):68-73.