

Comparison of Haemodynamic Parameters and Recovery Profiles of Desflurane Versus Sevoflurane in Patients Undergoing Laparoscopic Cholecystectomy

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Abstract

Introduction: Inhaled anaesthetics are the most widely used drugs for maintenance of general anaesthesia because of their ease of administration and predictable intraoperative and recovery characteristics. Newer inhalational agents such as Desflurane provide several advantages over the older inhalational agents. Desflurane has a very low blood-gas partition coefficient [about 30% less than Sevoflurane] and low oil-gas partition coefficient [about 64% less than Sevoflurane].

Objectives: Our main aim to conduct this study was to compare the hemodynamic parameters and recovery profiles after Desflurane vs. Sevoflurane anaesthesia in elective laparoscopic cholecystectomy patients. **Materials and Methods:** It was a comparative prospective randomized study conducted after consent from institutional ethical committee. Study included 80 ASA I-II patients aged between 20-60 years, of either sex scheduled for elective laparoscopic cholecystectomy. Patients were randomly divided into two groups of 40 patients each. Group 'D' received Desflurane as anesthetic agent and Group 'S' received Sevoflurane as anesthetic agent for maintenance of anesthesia. Hemodynamic parameters were observed perioperatively. Recovery profiles of patients were noted after giving reversal. Results were calculated using statistical tests. **Results:** Time required for eye opening, extubation, verbal response and to attain an Modified Aldrete score of ≥ 9 was significantly shorter in Group D as compared to Group S. Hemodynamic parameters [pulse, BP, SpO₂] were comparable in both groups. **Conclusion:** Desflurane administration in patients undergoing Laparoscopic Cholecystectomy was associated with stable peri-operative hemodynamic parameters, faster early recovery and not significantly higher side effects.

Keywords: Desflurane, Laparoscopic Cholecystectomy, Sevoflurane

1. Introduction

The history of inhalational anaesthesia can be very clearly divided into the pre and post Ether era. A large series of experiments, accidents and misadventures led us right through the formulation of nitrous oxide by John Priestly in 1773 to Henry Hill Hickman's attempts with carbon dioxide, up until the historic event on October 16, 1846, in the Bullfinch Amphitheatre of the Massachusetts General Hospital, where William Thomas Green Morton demonstrated the effects of Ether¹ and changed the course of surgery and anaesthesia forever².

Fluorine substitution for other halogens lowers the boiling point, increases stability, and generally decreases toxicity. Many fluorinated agents were used and discarded over the years till Isoflurane. Isoflurane has a pungent, ethereal odour making it unsuitable as a sole agent for induction^{3,4}. This was followed by introduction of newer fluorinated inhalational agents with low blood solubility. The low solubility in blood of these newest anaesthetics was desirable, because it would facilitate the rapid induction of anaesthesia, permit precise control of anaesthetic concentrations during maintenance of anaesthesia, and favour prompt recovery at the end of anaesthesia independent of the duration of

administration. New risks (airway irritation, sympathetic nervous system stimulation, carbon monoxide production, complex vaporizer technology, fluoromethyl-2,2-difluoro-1-[trifluoromethyl] vinyl Ether or compound A production) are associated with the administration of these new drugs⁵.

During the intraoperative period, the anaesthetic technique as well as the drugs used; optimize conditions for surgeons to operate while allowing for very early recovery of vital organ function after major procedures. Thus, the introduction of rapid short acting volatile anaesthetics [for example, Desflurane and Sevoflurane]⁶; opioids [for example, remifentanyl], and muscle relaxants have facilitated expansion of ambulatory surgery for minor to moderate procedures⁷.

Inhaled anaesthetics are the most widely used drugs for maintenance of general anaesthesia because of their ease of administration and predictable intraoperative and recovery characteristics⁸. Newer inhalational agents such as Desflurane provide several advantages over the older inhalational agents. Desflurane has a very low blood-gas partition coefficient [about 30% less than Sevoflurane] and low oil-gas partition coefficient [about 64% less than Sevoflurane]⁹.

Our main aim to conduct this study was to compare the hemodynamic parameters and recovery profiles after Desflurane vs Sevoflurane anaesthesia in elective laparoscopic cholecystectomy patients.

2. Aim

The aim of the study was to compare the perioperative hemodynamic parameters and recovery profiles of Sevoflurane and Desflurane in patients undergoing laparoscopic cholecystectomy.

3. Objectives

- To compare perioperative hemodynamic parameters between the two groups.
- To measure and compare the time taken for verbal response and eye opening to occur after the inhalational agent is switched off between the two groups.
- To measure and compare the time taken for complete recovery of patient (Aldrete score of ≥ 9) between the two groups.
- To document and compare adverse effects, if any, during extubation or early recovery such as excessive secretions, coughing or laryngospasm between the two groups.

4. Materials and Methods

After approval of the tertiary care hospital and Research Ethics Committee and written, informed consent of the patients this study was conducted.

Type of study- Randomized Prospective Comparative study.

Sample size- 80 patients. [40 patients in each group].

4.1 Inclusion Criteria

- ASA I and II patients.
- Age group 20-60 years.
- Patients undergoing Laparoscopic Cholecystectomy.

4.2 Exclusion Criteria

- Any Comorbid condition like Cardio-pulmonary dysfunction, Hepatic dysfunction, Renal dysfunction, Endocrine dysfunction, Neurological dysfunction.
- Pregnancy.
- Documented allergic reaction to the anaesthetic agent being used.
- Patient's refusal to participate in the study.

The patients were divided in two groups [n=40] and randomization was done using a computer generated table.

4.3 Group S

The patients receiving Sevoflurane [1-2%] as the anaesthetic agent for maintenance of anaesthesia.

4.4 Group D

The patients receiving Desflurane [3-6%] as the anaesthetic agent for maintenance of anaesthesia.

Pre-op medications and adjuvant medications during surgery except Sevoflurane [1-2%] and Desflurane [3-6%] were kept similar in both the groups. Sevoflurane was used in dosage of [1-2%] and Desflurane in dosage of [3-6%].

4.5 Day Prior to Surgery

- Thorough Pre-operative clinical assessment of each patient including history, general and systemic evaluation and routine investigations.
- Any other specific investigations as indicated.
 - Height and Weight of the patient.

- A written, informed and valid consent.

4.6 Inside the Operating Room

- Monitors in the form of the Pulse-oximeter [SpO₂], Non-Invasive Blood Pressure [NIBP], Electrocardiographic [ECG] monitors were attached.
- Baseline [preoperative] pulse rate, blood pressure, respiratory rate, Arterial oxygen saturation i.e., SpO₂ were recorded.
- IV cannulation was done using a 20G/18G cannula on the non-dominant hand and balanced salt solution was started.
- Anti-emetic in the form of Inj. Ondansetron 0.08 mg/kg body weight was given.
- All patients received Fentanyl citrate 2 mcg/kg and Glycopyrrolate 0.2 mg intravenously and were pre-oxygenated prior to induction of anaesthesia.
- Anaesthesia was induced with inj. Propofol 2 mg/kg IV. After loss of consciousness, ventilation of lungs was manually assisted.
- Neuromuscular blockade was achieved with inj. Atracurium besylate 0.5 mg/kg IV and the airway secured with an appropriately sized endotracheal tube after ventilating the patient for 3 minutes.
- The patient was then ventilated using a closed circuit and a mechanical ventilator.
- End tidal capnometry and anaesthetic gas monitoring was then be instituted.
- The patients subsequently received either Sevoflurane [1-2%] or Desflurane [3-6%] with 50% air in oxygen with fresh gas flows at 1 litre/minute.
- Muscle relaxation was maintained using intermittent doses of Atracurium besylate at appropriate intervals.
- Monitoring was done using SpO₂, Non-Invasive Blood Pressure [NIBP], Electrocardiogram [ECG], HR, End-Tidal Carbon Dioxide [EtCO₂] and anaesthetic agent monitoring.
- All the patients were ventilated to maintain an EtCO₂ of 32–36 mm Hg.
- Antacid Prophylaxis was given using Inj. Pantoprazole 40 mg.
- Analgesia in the form of Inj. Paracetamol 15 mg/kg body weight i.v., 0.1 mg/kg body weight, i.v., of Inj. Ondansetron as an anti-emetic and 40 mg i.v., of Inj. Pantoprazole to prevent gastric acid secretion were given to all patients.

- The primary anaesthetic was discontinued after the last skin suture is placed.
- The neuromuscular block was reversed with Inj. Glycopyrrolate 0.008 mg/kg and Inj. Neostigmine 0.05 mg/kg intravenously.
- All the parameters were recorded intra operatively and until the patient achieved an Aldrete score of 9 (30 minutes post operatively). Also, the time of the first incidence of eye opening, that of first verbal response and any untoward events if any did occur, in the form of excessive secretions, coughing or bronchospasm.

Appropriate statistical tests were used to analyze the data. All the values were expressed as mean +/- SD. The data was analyzed using Student's T-test (unpaired) and Chi Square test.

5. Observations and Results

In both the groups, patients' demographic data were comparable. There was no significant difference in age, sex distribution, weight, ASA status and duration of surgery in both the groups.

5.1 Intra Operative Haemodynamic Parameters

5.1.1 Heart Rate

The baseline heart rate along with heart rate at 1, 3, 5, 15 minutes intra operatively was comparable and non-significant as shown below in (Table 1).

5.1.2 Mean Arterial Pressure (MAP)

The baseline Mean Arterial Pressure and at 1, 3, 5, 15 minutes intra operatively were comparable and non-significant as shown below in (Table 2).

5.1.3 Arterial Oxygen Saturation [SpO₂]

The Arterial oxygen saturation i.e., SpO₂ was consistently maintained at 99-100 % throughout the procedures and post operatively in both the groups.

5.2 Recovery Profiles

5.2.1 Extubation Time

Inhalational agent was switched off immediately after last skin suture (closure). Time required for extubation from switching off inhalational agent was noted in

Table 1. Intra operative Heart Rate

Time Interval	Group D		Group S		p-value
	Mean	SD	Mean	SD	
Baseline	80.03	6.97	78.83	5.92	0.40, NS
Induction	83.13	6.54	82.80	5.43	0.8, NS
1 min	86.55	6.12	85.75	5.80	0.56, NS
3 min	89.63	6.80	88.20	5.95	0.32, NS
5 min	83.86	6.84	84.20	5.33	0.81, NS
15 min	79.36	6.65	79.83	5.07	0.73, NS

Unpaired t test: NS-Not Significant

Table 2. Mean Arterial Pressure (MAP)

Time Interval	Group D (mmHg)		Group S (mmHg)		p-value
	Mean	SD	Mean	SD	
Baseline	94.17	5.66	93.93	4.53	0.84, NS
Induction	98.06	4.61	97.78	3.78	0.76, NS
1 min	102.57	4.19	100.00	3.50	0.74, NS
3 min	106.75	4.07	108.23	3.07	0.07, NS
5 min	95.40	3.53	94.78	3.21	0.42, NS
15 min	80.60	2.42	79.50	3.48	0.10, NS

Unpaired t test; NS= Not Significant

both the groups. Mean extubation time observed was significantly less in the Desflurane group [Mean = 5.85 ± 1.61 min as compared to 9.33 ± 1.98 min, $P = 0.000^{**}$]. This difference was statistically found to be highly significant.

5.2.2 Heart Rate and Mean Arterial Pressure (MAP)

Heart rate and mean arterial pressure (MAP) were comparable in both the groups at skin closure, at extubation, 1 minutes, 3 minutes, 5 minutes, 10 minutes, 15 minutes, 30 minutes intervals; and all results at all intervals were statistically non-significant.

5.2.3 Modified Aldrete Score

Modified Aldrete score was compared in both the groups at skin closure, at extubation, 1 minutes, 3 minutes, 5 minutes, 10 minutes, 15 minutes and 30 minutes intervals. Modified

Aldrete score was significantly higher in Desflurane group as compared to Sevoflurane at all intervals except for 30 minutes at which all patients achieved Modified Aldrete score of 10. This difference in Modified Aldrete score was found to be highly significant at all intervals except for 30 minutes; as mentioned in the following data in (Table 3).

Table 3. Modified aldrete score

Time Interval	Group D		Group S		p-value
	Mean	SD	Mean	SD	
Extubation	7.28	0.64	6.05	0.96	0.000 ^{**} , HS
1 min	8.00	0.32	6.40	0.78	0.000 ^{**} , HS
3 min	8.48	0.60	7.25	0.71	0.000 ^{**} , HS
5 min	9.28	0.51	7.95	0.64	0.000 ^{**} , HS
10 min	9.98	0.16	8.85	0.70	0.000 ^{**} , HS
15 min	10.00	0.00	9.55	0.50	0.000 ^{**} , HS
30 min	10.00	0.00	10.00	0.00	1, NS

Unpaired t test: S-significant, NS-non significant, HS-highly significant

5.2.4 Time Required to Achieve Modified Aldrete Score of 9

Time required to achieve modified aldrete score of 9 which was taken as a cut-off point as an indicator of complete recovery was compared in both groups. Time required to achieve modified aldrete score of 9 was found to be significantly less in the Desflurane group [Mean = 4.08 ± 1.53 min as compared to 10.83 ± 3.66 min, $P = 0.000^{**}$] and this difference was highly significant.

5.2.5 Time Required for Eye Opening

Time required for eye opening was noted and compared in both the groups. Time required for eye opening was less in the Desflurane group [Mean = 4.28 ± 0.95 min as compared to 6.39 ± 1.47 min, $P = 0.000^{**}$] and this difference was highly significant.

5.2.6 Time Required for Verbal Response

Time required for first verbal response was noted and compared in both the groups. Time required for verbal response was less in the Desflurane group [Mean = 7.70 ± 1.91 min as compared to 11.43 ± 2.45 min, $P = 0.000^{**}$] and this difference was highly significant.

5.3 Postoperative Complications

Postoperative complications post extubation were assessed and compared in both the groups and it was observed that the incidence of secretions was higher in Group D (5%) patients when compared to Group S (2.5%). But this difference was not statistically significant.

There was one incidence of coughing in Group S (2.5%) and one incidence of bronchospasm in group D (2.5%). This difference in occurrence of complications was not found statistically significant as mentioned in the data below in (Table 4).

Table 4. Over all complications

Complications		Group		Total
		Desflurane	Sevoflurane	
Secretions	No.	2	1	3
	%	5.00%	2.50%	3.75%
Coughing	No.	0	1	1
	%	0.00%	2.50%	1.25%
Bronchospasm	No.	1	0	1
	%	2.50%	0.0%	1.25%
No complication	No.	37	38	75
	%	92.50%	95.00%	93.75%
Total	No.	40	40	80
	%	100.0%	100.0%	100.0%

6. Discussion

Desflurane¹⁰ was introduced in India after Sevoflurane¹¹. Desflurane appeared to fit the profile required for drugs which can be used for ambulatory anaesthesia i.e., drugs allow rapid early recovery. In our institute we have been using Sevoflurane for the procedures that require early recovery¹². We planned this study with the purpose of introducing the newer agent, Desflurane, to our institutional laparoscopy protocol assuming that it would fit the criteria that,

- It would allow easy titration of depth of anaesthesia.
- It would not metabolise in the body to form products that would cause delayed awakening.

In our study, all 80 patients were comparable on the basis of age, ASA status, baseline vital parameters with non-significant statistical variability. Slight female dominance can be attributed to the fact that cholelithiasis is more common in females than in males. Njeze GE¹³ states that women during their fertile years are almost twice as likely as men to experience cholelithiasis. However, among the two groups the sex distribution was not statistically significant ($P = 0.35$). Intra operative hemodynamic parameters; heart rate (Table 1), Mean Arterial Pressure (Table 2), SpO₂ were also comparable in both the groups.

In our study, we switched off the maintenance agent at skin closure. We hypothesised, that since Desflurane leads to a faster wash out of the agent, the time required to allow us to extubate the patient should also be shorter. Our data analysis revealed that the duration from switching off the agent to extubation was consistently less in the Desflurane group [Mean = 5.85 ± 1.61 min as compared to 9.33 ± 1.98 min, $P = 0.000^{**}$]. Our study was supported by the findings of Nathanson MH et al.¹⁴, Dupont J et al.,¹⁵, Magni G et al.,¹⁶ and Dexter F et al.,¹⁷ in different groups of patients.

Immediate post-operative heart rate and Post-operative mean arterial pressure at skin closure, at extubation, 1 minutes, 3 minutes, 5 minutes, 10 minutes, 15 minutes, 30 minutes intervals were compared in both the groups and all results at all intervals were statistically non-significant.

Modified Aldrete score was significantly higher in Desflurane group as compared to Sevoflurane at all intervals (Table 3) except for 30 minutes. Time required to achieve Aldrete score of 9 was significantly less in Desflurane group [Mean = 4.08 ± 1.53 min as compared to 10.83 ± 3.66 min, $P = 0.000^{**}$]. This finding was also supported by Jindal et al.,¹⁸ and Eshima RW et al.¹⁹

Time required for eye opening was significantly less in Desflurane group [Mean = 4.28 ± 0.95 min as compared to 6.39 ± 1.47 min, $P = 0.000^{**}$]. Time required for verbal response was also significantly less in Desflurane group [Mean = 7.70 ± 1.91 min as compared to 11.43 ± 2.45 min, $P = 0.000^{**}$]. This finding was supported by the works of La Colla et al.²⁰, and Kaur A et al.²¹.

Postoperative complications post extubation were assessed and it was observed that the incidence of secretions was higher in Group D patients when compared to Group S. But this difference was not statistically significant.

There was one incidence of coughing in group S and one incidence of bronchospasm in group D. This difference in occurrence of complications was not found statistically significant (Table 4).

7. Conclusion

From our study entitled “The comparison of haemodynamic parameters and recovery profiles of desflurane versus sevoflurane in patients undergoing laparoscopic cholecystectomy” we conclude that:

Desflurane administration in patients undergoing Laparoscopic Cholecystectomy has no negative effects on the intra-operative as well as on early post-operative haemodynamic parameters.

Desflurane as the inhalational agent ensures faster recovery in the early post-operative period as evident from significant decrease in the time required for extubation and the time required to achieve Modified Aldrete score of ≥ 9 .

The patients receiving Desflurane also opened their eyes and verbalised sooner. It was also not associated with any significant adverse effects.

Thus, Desflurane administration in patients undergoing Laparoscopic Cholecystectomy was associated with stable intra operative haemodynamic parameters, faster early recovery and not significantly higher side effects.

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