# A COMPARATIVE STUDY OF DESFLURANE AND SEVOFLURANE IN TERMS OF HEMODYNAMICS AND POSTOPERATIVE RECOVERY IN LAPAROSCOPIC APPENDICECTOMY

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**Abstract**

**Background and Aims**: Desflurane and Sevoflurane, having similar blood-gas co-efficients, are expected to demonstrate faster recovery from anesthesia. We conducted this study between Desflurane and Sevoflurane to evaluate and compare emergence, postoperative recovery and also their efficiency in maintaining stable intraoperative hemodynamics.

**Methods:** This prospective, randomised, double-blinded study was conducted on 60 American society of Anesthesiologists (ASA) I and II patients, aged between 20 to 50, who underwent elective laparoscopic appendicectomy under general anesthesia. We followed institutional general anesthesia protocol with either 4% Desflurane (Group D=30 patients) or 1% Sevoflurane (Group S=30 patients). Intraoperative vitals and postoperative scoring for recovery were noted and SPSS version 17 was used for the statistical analysis.

**Results:** Heart rate was comparable in both the groups; blood pressure was comparatively maintained in a lower range in sevoflurane group than desflurane group ($p \leq 0.05$ during most of the intraoperative period), although not clinically significant. Group D patients showed earlier response to pain (9.4±2.2 vs 2.8±1.2; $p<0.01$), oral commands (11.9±2 vs 4.6±1.6; $p<0.01$), spontaneous eye opening (14.8 ±2.4 vs 6.6 ±1.9; $p<0.01$), handgrip (17 ±2.7 vs 8.6 ± 1.8; $p<0.01$). A full scoring in modified Aldrete scale was also achieved significantly earlier in desflurane group ($p<0.01$) compared to sevoflurane.

**Conclusion:** Emergence and recovery is earlier with desflurane than sevoflurane, with similar intraoperative hemodynamics in patients undergoing laparoscopic appendicectomy.

**Keywords:** hemodynamic, recovery, desflurane, sevoflurane.

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## 1. Introduction

Cost effective surgery has seen an explosive growth over the last decade and ambulatory surgery has peaked its popularity. Volatile anesthetics, a part of the balanced anesthesia plays an important role in this cost-effective trend. Volatile agents are expected to provide smooth and rapid induction, optimal operating conditions, rapid recovery with minimal or no side effects, and fast tracking. Stable intraoperative hemodynamics will reduce the consumption of other anesthetic drugs. Early recovery not only reduces the hospital stay but also makes its more acceptable from patient's perspective. Early recovery from desflurane and sevoflurane anesthesia is contributed to their low solubility; the blood‑gas partition coefficient of desflurane and sevoflurane being 0.42 and 0.69 respectively. So this study was conducted to compare and evaluate the intraoperative hemodynamics and post-operative response to pain, oral commands, spontaneous eye opening , handgrip; along with modified aldrete scoring between desflurane and sevoflurane in general anesthesia under controlled environment.

## 2. Methods

**Methodology**

After approval from ethical committee and written informed consent, 60 patients aged 20-50 years, of ASA Grade I and II, undergoing laparoscopic appendicectomy under general anaesthesia lasting from 45 minutes up to 2 hours were selected for this study. They were randomly divided into group D and group S using a computer-generated random number technique with 60 patients in each group. Group D received 4% desflurane and Group S received 1% sevoflurane according to the code in the sealed envelope. Every patient had to undergo a pre-anesthetic assessment before subjecting to surgery. They were subjected to basic blood investigations that included complete blood count, renal and liver function tests, thyroid profile, electrocardiograph and chest x-ray. The patients were kept nil per oral according to standard guidelines before surgery (6 hours for solid diet and 4 hours for liquid diet).

Code number was put on participants proforma sheet, and decoding was done at the end of the study by the statistician. On arrival in the operating room, patients were connected to basic monitors such as electrocardiogram, pulse-oximeter and non-invasive blood pressure monitor. A 18G peripheral venous cannula was inserted and intravenous fluids was started.

Premedication was done with Injection (Inj.) Glycopyrrolate 5mcg/kg iv, Inj.Midazolam 50mcg/kg iv, Inj.Ondansetron 15mcg/kg iv, Inj.Fentanyl 2mcg/kg iv. Preoxygenation was done with 100% $O_2$ for three minutes. The patients were induced with Inj.Propofol 2mg/kg iv and Inj.Succinycholine 2mg/kg iv was given for facilitating intubation and intubated with appropriate sized endotracheal tube and fixed after checking bilateral equal air entry. Patients were paralysed with Inj.Vecuronium 0.1mg/kg iv and maintenance dose was given according to patient's spontaneous respiratory efforts. Anaesthesia was maintained with 1:1 $N_2O$:$O_2$ in a closed circuit system. The concentration of inhalation agent was maintained at 4% for Desflurane in group D and 1% for Sevoflurane in group S throughout the procedure. Inj.Fentanyl 0.5mcg/kg was given to control any acute hemodynamic changes (Heart rate and blood pressure above 20% from baseline values) not responding to the set inspired concentration of volatile agent. Volatile agent was discontinued at the time of start of skin closure. The time of discontinuation of the volatile agent was noted as T0. Surgeons were asked to complete skin closure in 3 mins to maintain standardization. Inj.Neostigmine 0.05mg/kg iv and Inj.Glycopyrrolate 0.01mg/kg iv were given after adequate spontaneous respiratory efforts. The time taken from T0 to respond to pain and verbal stimuli, the time taken for spontaneous eye opening and squeezing finger/hand-grip was recorded. Emergence from anesthesia was the time taken from the discontinuation of volatile anesthetic till the patient was extubated. When all the four emergence parameters were achieved, patient was extubated. The time of extubation was noted. Patient was shifted to recovery room after extubation. Recovery from anesthesia was the time taken from the discontinuation of volatile anesthetic till the patient achieved a

score of 10 in Modified Aldrete scale. In the recovery room, Modified Aldrete Score was recorded on arrival, 5 minutes and 10 minutes after arrival. Parameters were recorded by an anesthetist who was blinded to the study.

The following parameters were measured and documented throughout the procedure:

- Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure at baseline, Pre-induction, at intubation, 1 minute after intubation, 5 minutes after intubation and thereafter every 15 minutes till the end of anaesthesia.
- Time of discontinuation of inhalation agent and time of extubation were recorded.
- Time of discontinuation of inhalation agent was considered as TIME 0 for recording postoperative outcome parameters.
- Time to respond to pain, response to verbal commands, spontaneous eye opening, squeezing finger/handgrip were taken as emergence parameters.
- Modified Aldrete Score on arrival at recovery room, 5 minutes and 10 minutes after arrival at recovery room were taken as recovery parameters.
- Total doses of Inj.Vecuronium and Inj.Fentanyl given were also recorded.

With reference to previous study done by S Gergin et al (13), assuming 95% confidence interval, 80% power and 5% alpha error, the sample size was calculated using open epi software 3.0. to be 60.

The study was done for a period of eight months. Data collected from 60 patients were compiled into a master chart which included all the recorded parameters from the study. IBM.SPSS statistics software 23.0 Version to describe about the data descriptive statistics. Frequency analysis and Percentage analysis were used for categorical variables and the Mean and Standard Deviation were used for continuous variables. To find the significant difference between the bivariate samples in independent groups, the Unpaired t-test was used.

## 3. Results

We enrolled 60 patients each in group D and group S. the demographic chararcteristics were comparable in both the groups (Table 1). The mean age of patients were 31.1±8.2 and 31.6±7.8 (p=0.8096), the mean weight of the patients were 52.4±7.8 and 53.1±8.1(p=0.7344). Gender distribution was comparable between the groups (p=0.254). The mean duration of surgery was 65.4±8.7 in group D and 66.6±11.6 in group S (p=0.65) and 51 out of 60 patients belonged to ASA I category, with 9 from the ASA II category (p=0.278). No patients experienced any adverse outcome during the study.

Table 1: Demographic characteristics of the patients in two groups

| **Demographic characteristics** | **Total** | **Group D** | **Group S** | **P** |
|---|---|---|---|---|
| Age (years) | 20-50 | 31.1±8.2 | 31.6±7.8 | 0.8096 |
| Gender (M/F) | 52/8 | 24/6 | 28/2 | 0.254 |
| Weight (kg) | - | 52.4±7.8 | 53.1±8.1 | 0.7344 |
| ASA (I/II) | 51/9 | 27/3 | 24/6 | 0.278 |
| Duration of surgery (mins) | - | 65.4±8.7 | 66.6±11.6 | 0.65 |

Data is presented in the form of mean±SD or actual numbers; ASA - American Society of Anesthesiologists.

Table 2: Comparison of emergence parameters between the two groups

| **mergence parameter** | **Group D** | **Group S** | **P** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Response to pain (mins) | 2.8±1.2 | 9.4±2.2 | 0.001 |
| Response to verbal commands (mins) | 4.6±1.6 | 11.9±2 | 0.001 |
| Spontaneous eye opening (mins) | 6.6 ±1.9 | 14.8 ±2.4 | 0.001 |
| Time to handgrip (mins) | 8.6 ± 1.8 | 17 ±2.7 | 0.001 |

Series of time gaps between two perioperative events for each patient is presented as mean±SD.

Table 3: Comparison of Modified aldrete score between the two groups

| **Recovery parameter** | **Group D** | **Group S** | **P** |
|---|---|---|---|
| On arrival in recovery room | 10 | 8.4±0.8 | 0.001 |
| After 5 minutes | 10 | 8.9±0.8 | 0.001 |
| After 10 minutes | 10 | 10 | - |

On evaluating the hemodynamic parameters – heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure, we found that after intubation, group S had lower blood pressure values (systolic blood pressure, diastolic blood pressure and mean arterial pressure) compared to group D and this difference was statistically significant ($p<0.01$). Although the blood pressure recordings showed statistical significance, they were not clinically significant, because all the intraoperative blood pressure readings were within 20% from the baseline values of the patients. Heart rate was comparable between the two groups. So, intra-op hemodynamic stability was similar in both the groups (Fig1).

The mean time for response to pain stimulus in group S was 9.4±2.2minutes and in group D it was 2.8±1.2 minutes. The mean time to respond to verbal commands in group S was 11.9±2minutes and in group D it was 4.6±1.6 minutes. The mean time for spontaneous eye opening in group S was 14.8±2.4minutes and in group D it was 6.6±1.9 minutes (Fig 2). The mean time for squeezing finger or handgrip response in group S was 17±2.7minutes and in group D it was 8.6±1.8 minutes. On analyzing the above emergence parameters, we found that group D had rapid emergence characteristics with significant p values ($p<0.01$) when compared to group S (Table 2).

The recovery status of the patients was assessed in the recovery room with Modified Aldrete score. The on arrival score was 8.4±0.8 in group S, after 5 minutes it was 8.9±0.8, only on the $10^{th}$ minute recording a score of 10 was achieved in group S; whereas the on arrival score itself was 10 in group D (Table 3). Hence statistical significance ($p=0.001$) was proved between the two groups with regard to modified Aldrete scoring.

In addition to these, the requirement of opioids and muscle relaxants were noted and statistical analysis done. On statistical analysis, the usage of vecuronium was significantly low in group S (group D - 5.3±0.8 vs group S - 4.8±0.7; $p=0.024$). Requirement of opioid was comparable in both the groups (106.3±14 vs 104.6±16; $p=0.68$).

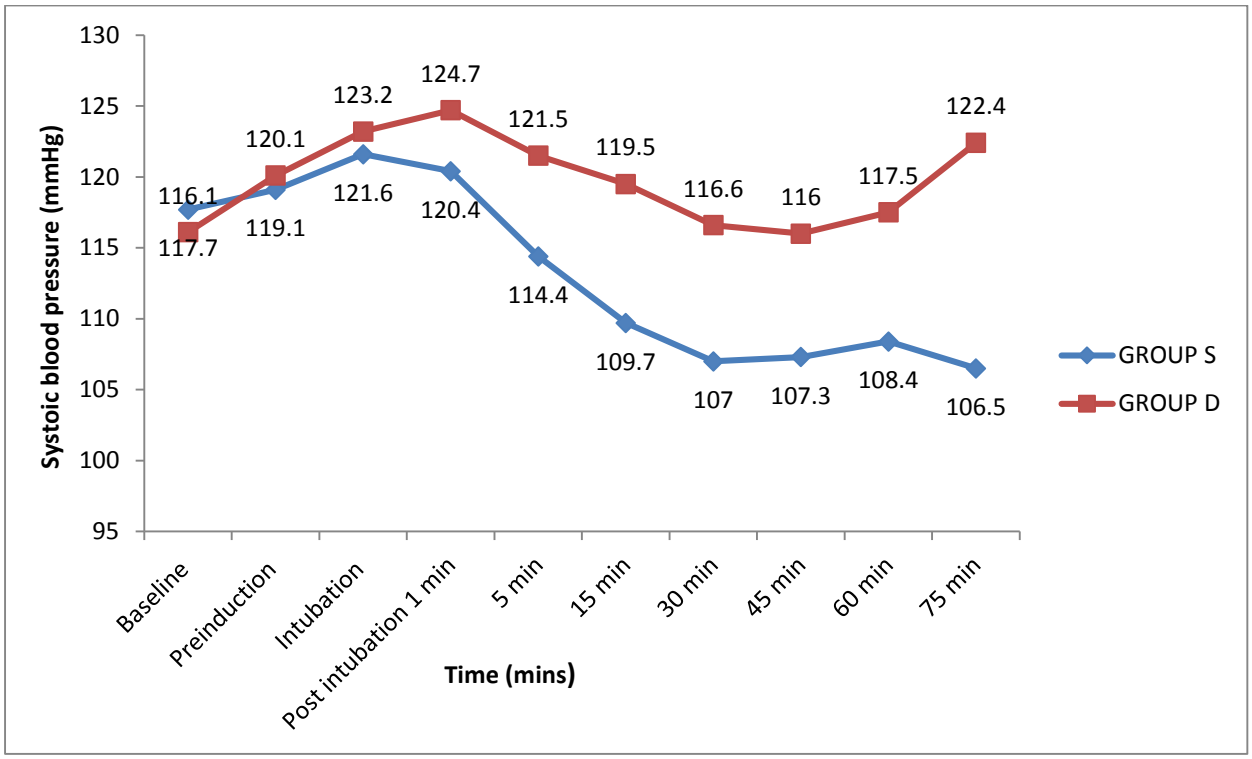


**Fig 1: Comparison of systolic blood pressure between two groups**

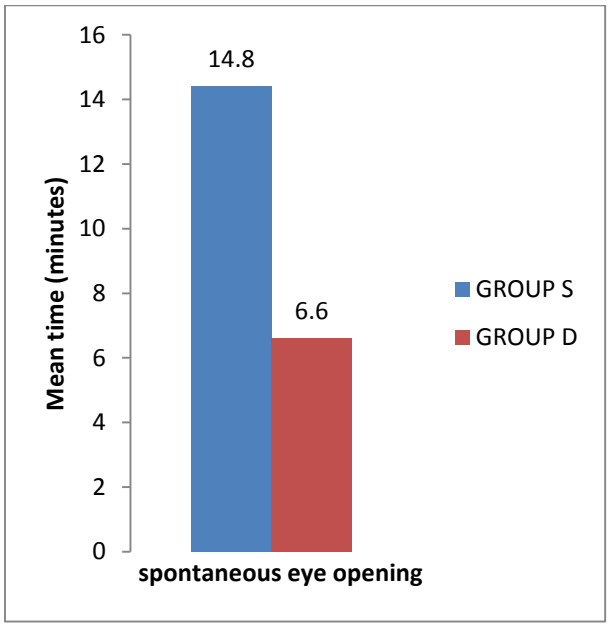


**Fig 2: Comparison of time taken for spontaneous eye opening between the two groups**

## 4. Discussion

In a world of growing demands, now is the era of day care surgery. Patients expect a deep plane of anesthesia and early discharge at the same time in a cost-effective approach too. Factors like age, ASA status, duration of anesthesia, thyroid profile of the patient, choice of anesthetic drugs can also affect the recovery profile. In this study we standardised age, sex, weight, duration of surgery and the ASA status. During the pre-anesthetic investigation all of them were found to have a normal thyroid profile. Volatile agents, being an important part of balanced anesthesia can provide a deep plane of anesthesia and early recovery provided they have a low blood gas coefficient.

We decided to compare desflurane and sevoflurane in laparoscopic appendicectomy patients regarding intraoperative hemodynamic status and recovery profile. Although both have similar blood-gas partition co-effecients, research has shown significant differences in recovery status.

In our study we adminitered 4% desflurane in group D and 1% sevoflurane in group S. The dial concentration was fixed at 4% for Desflurane and 1% for Sevoflurane as they were equi-MAC concentrations. 1 MAC of desflurane is 6.6% and sevoflurane is 1.8% (12). According to Lobo et al (8) using 0.5 MAC of nitrous oxide (54%) with 0.5 MAC of any volatile will have a clinical effect of 1 MAC of the volatile agent. Addition of 66% nitrous oxide to desflurane reduces the MAC by 53%, which comes around 3.3% dial concentration (9,11). Kapoor MC and Vakamudi M (10) in their study have calculated that the MAC of desflurane in 30-65year old age group is 5.75-6.25 with 100% oxygen and 1.75-3.25 with 60% nitrous oxide. Taking into consideration the above said data, we calculated that the 0.5 MAC of desflurane was 4% when given along with 50% nitrous oxide. The dial concentration for achieving a 0.5 MAC of sevoflurane is 1% (8) and the dial concentration for achieving a 0.5 MAC of desflurane is 4% (9,10,11).

For evaluating the intraoperative hemodynamics, we recorded and analysed blood pressure (as systolic, diastolic and mean arterial pressure) and heart rate. In our study, heart rate was comparable between the two groups. With regard to Blood pressure, we could only prove statistical significance between the two groups. Blood pressure was maintained at a lower range in sevoflurane group than desflurane group. But it was within the 20% limit from the baseline values of patients. Hence the values were not clinically significant between group D and group S.

Osmanagoaglu et al in his study of 45 abdominal surgery patients concluded desflurane had significantly higher heart rate values upto 60 minutes post intubation, when compared to sevoflurane group. In our study although heart rate values were higher in desflurane group from 45-75 minutes post intubation, we dint have significant differences until 45 minutes of intubation (2). Bastola et al has performed a study involving 75 patients posted for elective supratentorial craniotomy. In contrast to this study, their study has proved that sevoflurane had higher heart rate and blood pressure values compared to desflurane (1). Many other studies have concluded sevoflurane and desflurane as comparable in terms of hemodynamic parameters. Although there are recent studies on desflurane vs sevoflurane recovery parameters, there are no recent studies comparing these two volatile agents on hemodynamic status. So this study has brought some light on the hemodynamic properties between the two similar volatile agents.

We have studied both emergence and recovery parameters in this research. Emergence from anesthesia is defined as the time taken from the discontinuation of volatile agent till the patient is extubated (7). Recovery from anesthesia is the time taken from the discontinuation of volatile agent till the patient achieves a score of 10 in modified Aldrete score (7). The emergence property of desflurane and sevoflurane was evaluated by recording the time taken for the patient's response to pain, response to verbal commands, spontaneous eye opening and squeezing hand/finger grip after discontinuation of volatiles. Modified Aldrete Score on arrival, 5minutes and 10minutes after arrival in the recovery room was used in our study to assess the recovery from anesthesia. In our study, both emergence and recovery parameters were achieved earlier in Desflurane group than Sevoflurane group. Hence it can be concluded from our study that desflurane is the volatile of choice in day care surgeries, where not only early emergence from anesthesia, but also faster recovery and discharge of patients is mandatory.

Dalal et al has studied on 94 patients who underwent hysteroscopic surgery and the statistical analysis has shown faster recovery from desflurane anesthesia compared to sevoflurane anesthesia. They have compared volatile agents with the parameters like: time taken for eye opening, response to oral commands, ability to sit and the time taken for orientation (3). Gupta et al has concluded similar findings in pediatric patients posted for

spinal dysraphism. Gupta et all in their study has assessed recovery with the time taken for emergence, time for extubation and the time taken to attain maximum modified aldrete score in both desflurane and sevoflurane group (4). Jindal et al in their study on 100 patients who underwent daycare laparoscopic gynaecological procedures has concluded that desflurane has earlier emergence and recovery parameters, similar to our study (5).

In addition to these outcomes, we have also studied the total requirement of vecuronium and fentanyl during the intraoperative period. The total requirement of fentanyl was comparable between the groups, but sevoflurane group had less requirement of vecuronium than desflurane group. There are studies that support that sevoflurane can enhance neuromuscular blockade by increasing the sensitivity of the skeletal muscles to neuromuscular blocking drugs (6). But no studies have proved it so far clinically.

On compiling, although there are many studies that have done similar projects, many have reported either alternate results or confusing results that dint have a definite conclusion. The sample size was calculated with 95% power and 0.05 significance. In our study we have standardised all the demographic and certain other parameters like duration of surgery, choice of anesthetic drugs that were also capable of affecting the recovery status of the study subjects. Also we have used standardised parameters for assessing all the objectives of the study.

On standardising all the factors that could influence the deviation of results, we have conducted our study on 60 patients, all of whom underwent laparoscopic appendicectomy under standardised general anesthesia conditions. Data like intraoperative hemodynamic parameters, emergence parameters and modified aldrete scores were recorded by a anesthesia technician who was blind to the study. On statistical analysis of the data, we concluded that sevoflurane has better intraoperative hemodynamic stability and desflurane has early emergence and recovery profile.

The above conclusion is highly applicable. Whenever early recovery is warranted, be it a daycare procedure or a geriatric or a hypothyroid patient or an obese patient, Desflurane becomes the drug of choice. And stable intraoperative hemodynamics can always lead to a cost effective approach because it requires a lesser consumption of other anesthetic agents. Neuromuscular blocking agent consumption has also proved to be less with sevoflurane anesthesia. Hence our study has proved high practical implication in anesthesia practise.

Our study also has certain limitations. We dint consider the effect of nitrous oxide co-administration with volatile. Future studies can be encouraged considering using air instead of nitrous oxide, and post anesthesia discharge scoring system can also be used in addition in future studies.

## 5. Conclusion

In this randomised comparative study between Sevoflurane and Desflurane for laparoscopic appendicectomy surgeries under general anaesthesia, we conclude that Sevoflurane and Desflurane provide similar intraoperative hemodynamics. Desflurane has early emergence and postoperative recovery than Sevoflurane. However, Sevoflurane has less requirement for muscle relaxant than Desflurane.

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**Conflicts of interest:** There are no conflicts of interest.

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