Sevoflurane Vs Desflurane: Haemodynamic Parameters And Recovery Characteristics

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Abstract
The purpose of this study was to compare the haemodynamic, emergence and recovery characteristics of sevoflurane with those of desflurane in nitrous oxide anaesthesia. Forty patients were randomly assigned to receive either sevoflurane 1 % or desflurane 3 % for maintenance of general anaesthesia after standardized induction sequence. Measurements of haemodynamics occurred every 2 min prior to skin incision and every 5 min thereafter. The times for discontinuation of inhaled anaesthetics to spontaneous movement, response to painful stimuli, extubation, recall of name and handgrip on command were measured. Mean anaesthesia duration was 96.2 ± 28.85 min and 124.65 ± 48.81 min in sevoflurane and desflurane groups respectively (p<0.05). Time to extubation, recall of name and handgrip on command were shorter in the desflurane group (p<0.01). At fifth and fifteenth minutes, significantly higher percentages of patients in the desflurane group had recovery scores of ≥ 10. Desflurane offers a transient advantage compare with sevoflurane with respect of early recovery even though the duration of anaesthesia was longer in the desflurane group.

INTRODUCTION
Inhaled volatile anaesthetics remain the most widely used drugs for maintenance of general anaesthesia because of their ease of administration and predictable intraoperative and recovery characteristics. Management of haemodynamic stability and early recovery is the most important part of a standardized balanced technique. 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 anaesthetics (1,2).

The purpose of this prospective randomised study was to compare the haemodynamic and recovery characteristics of sevoflurane with those of desflurane in nitrous oxide anaesthesia.

METHODS
After institutional Ethics Committee approval and informed consent, forty ASA I-II patients scheduled for cholecystectomy were enrolled into the study. Patients with clinically significant cardiovascular, respiratory, hepatic, renal, neurologic, psychiatric and metabolic disease or those who had undergone a recent anaesthetic (within the previous 7 days) were excluded. Also excluded were patients with a history of allergic reactions to drugs and patients chronically receiving opioid analgesics or sedative medication. Randomisation was by means of sealed envelope.

Patients were premedicated 30 min before surgery with 0.05 mg kg⁻¹ midazolam intravenously. Monitoring included continuous ECG, pulse oximetry, non-invasive blood pressure, end-tidal carbon dioxide (ETCO₂), end-tidal sevoflurane (ETsevo) and end-tidal desflurane (ETdes) (AMS CAMS II anaesthesia monitor)). Patients were assigned into two groups to receive either sevoflurane 1 % or desflurane 3 % for maintenance of general anaesthesia with nitrous oxide 50 % in oxygen via a semiclosed system after standardized induction sequence consisting of fentanyl 1µ g kg⁻¹, thiopenthal 4-7 mg kg⁻¹ and vecuronium 0.1 mg kg⁻¹ intravenously.
After endotracheal intubation, ventilation was controlled to maintain ETCO\textsubscript{2} between 35 and 40 mmHg (AMS 200 Anaesthesia Workstation)). Adjustment of volatile anaesthetic concentration maintained mean arterial blood pressure (MAP) and heart rate (HR) within 20% of the preinduction baseline values or by clinical signs of light anaesthesia (lacrimation, flushing or sweating). ET\textsubscript{sevo} and ET\textsubscript{des} concentration was increased by increments of 1.0%. If MAP or HR remained increased after 5 min supplemental dose of fentanyl (0.5 µg kg\textsuperscript{-1}) was given. Atropine 0.5 mg was given intravenously when heart rate dropped below 45 beats min\textsuperscript{-1}. Anaesthetics were decreased only in response to hypotension not responsive to replacement of intraoperative fluid loss or treatment of bradycardia. Vecuronium maintained neuromuscular blockade, as determined by one twitch visible of the train-of-four.

Nitrous oxide was discontinued at the first skin suture. At the last skin suture, the volatile agent was stopped and controlled ventilation with 100% oxygen 8 l min\textsuperscript{-1} was continued until end-tidal volatile anaesthetic concentration was less than 0.1%. Residual neuromuscular blockade was reversed with a combination of neostigmin 2 mg and atropine 0.5 mg intravenously.

The time of discontinuation of anaesthetic agents was noted as time zero for all subsequent measurements and recovery times were determined at 1-min intervals to awakening. The trachea was extubated when a regular spontaneous breathing pattern was reestablished and when patients were able to open their eyes on command. The time to the first spontaneous motion and response to painful pinch was noted and patients were asked to squeeze fingers and give their names. In addition, post-anaesthesia recovery score (PARS) of Aldrete and Kroulik were noted at the same time intervals. This score records vital signs with patients receiving 0-13 points that is 0-3 points for six physiological variables (Table 1). One designated investigator administered all anaesthesia; another assessed recovery.

Any intra-and postanaesthesia adverse events were assessed and recorded. Postoperatively, antiemetics (metoclopramide 10-20 mg iv) were administered for nausea and vomiting, and opioid analgesics (e.g., meperidin 25-40 mg iv, tramadol 20-50 mg iv) were given for moderate-to-severe pain.

**STATISTICS**

Statistical analysis was performed using the SPSS (Statistical Package for Social Sciences) for Windows 10.0. Data are reported as mean values, with variability expressed as standard deviation (SD). The two-tailed Student’s unpaired t-test and analysis of variance (ANOVA) were used to parametric data. All non-parametric data were analysed using chi-square test. P values no greater than 0.05 were considered as statistically significant.

**RESULTS**

The patients’ characteristics are detailed in Table 2. There was no statistically significant difference between the two treatment groups with respect to gender, age, body weight, body height, and ASA classification. In addition, there were no significant differences in the total doses thiopental, fentanyl or vecuronium administered during the operations. Mean anaesthesia duration was significantly longer in desflurane group (p<0.05).
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Figure 2
Table 2: Patients’ demographic characteristics and drug requirements.

<table>
<thead>
<tr>
<th></th>
<th>Sevoflurane group (n=20)</th>
<th>Desflurane group (n=20)</th>
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<tbody>
<tr>
<td>ASA classification</td>
<td>15/5</td>
<td>15/5</td>
</tr>
<tr>
<td>Gender</td>
<td>9/11</td>
<td>4/16</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>42.36 ± 9.54</td>
<td>46.95 ± 11.28</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>82.69 ± 11.74</td>
<td>73.55 ± 10.29</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>186.5 ± 7.91</td>
<td>184.7 ± 7.07</td>
</tr>
<tr>
<td>Duration of anaesthesia (min)</td>
<td>90.2 ± 29.06</td>
<td>124.65 ± 48.01*</td>
</tr>
<tr>
<td>Total thecural dose (mg)</td>
<td>470 ± 78.72</td>
<td>476.75 ± 76.20</td>
</tr>
<tr>
<td>Fentanyl dose (µg)</td>
<td>80 ± 25.60</td>
<td>80.75 ± 13.48</td>
</tr>
<tr>
<td>Vecuronium dose (mg)</td>
<td>10.7 ± 2.69</td>
<td>11.9 ± 2.67</td>
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Data are means ± SD, *p < 0.05

Intraoperative changes in MAP and HR are summarized in Figure 1. The groups did not differ in these haemodynamic measures. In both groups, just before incision (anaesthetized patients awaiting stimulation), MAP and HR demonstrated an expected decrease and the minimum values were recorded immediately prior to skin incision (p<0.05 by repeated measures analysis of variance). During the maintenance period, MAP and HR were satisfactorily maintained within ± 20% of baseline values with both anaesthetics. End-tidal concentrations of sevoflurane and desflurane were 1.5% ± 0.4% and 4.5% ± 1.5% respectively, at the end of the operation.

Figure 3
Figure 1: Changes of (a) heart rate (HR, beat.min⁻¹) and (b) mean arterial pressure (MAP, mmHg) in both groups. Data are means ± SD.

Figure 4
The times to tracheal extubation, recall of name and handgrip were significantly shorter in the desflurane group. The time from early emergence from anaesthesia until arrive in the postanaesthesia care unit (PACU) was comparable between both groups. PARS greater than 10 was significantly earlier in desflurane group. Although the significant difference at 15 min, at 30 min, there were no differences in the recovery scores between the two groups (Table 3).

Figure 5
Table 3: Recovery times after discontinuation of the inhaled agent (min).

<table>
<thead>
<tr>
<th></th>
<th>Sevoflurane group (n=20)</th>
<th>Desflurane group (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous movement</td>
<td>4.40 ± 1.76</td>
<td>3.00 ± 1.86</td>
</tr>
<tr>
<td>Response to painful pinch</td>
<td>5.25 ± 2.24</td>
<td>4.25 ± 1.97</td>
</tr>
<tr>
<td>Extubation</td>
<td>7.05 ± 2.35</td>
<td>5.40 ± 1.23**</td>
</tr>
<tr>
<td>Recall of name</td>
<td>8.00 ± 3.01</td>
<td>6.10 ± 14.4**</td>
</tr>
<tr>
<td>Hand grip</td>
<td>8.00 ± 2.79</td>
<td>5.90 ± 1.52**</td>
</tr>
<tr>
<td>PARS&gt;10</td>
<td>11.58 ± 2.18</td>
<td>9.65 ± 5.55*</td>
</tr>
</tbody>
</table>

Data are means ± SD, *p<0.05, **p<0.01

Although the incidence of nausea and/or vomiting after surgery was greatest in the desflurane group (35% and 45% in the sevoflurane and desflurane groups, respectively), this difference was not statistically significant (p>0.05). There were no other complications with respect to the need for therapeutic interventions.

DISCUSSION
It is desirable to have a fast recovery from anaesthesia. The time to extubation, recall of name and handgrip was shorter in desflurane group. PARS scores reached to 10 earlier in desflurane than sevoflurane patients.

Bennett et al. found no difference in early emergence parameters (times to eye opening, hand grip and recall of name and date of birth) between desflurane and isoflurane groups. Their results indicated that desflurane like isoflurane
could maintain haemodynamic stability in concentrations producing surgical anaesthesia.\(^{(3)}\) In another study, findings showed that desflurane might be more successful in controlling hypertensive responses than isoflurane.\(^{(4)}\)

In comparison of desflurane and propofol for postanaesthetic and residual recovery, it’s found that awakening and early psychomotor recovery for long as 1 h after anaesthesia was faster after desflurane than propofol, but there was no difference in residual effects \(^{(5)}\). When opioid-based anaesthesia (e.g. remifentanil) was preferred there was no significant difference between desflurane and propofol in time to emergence from anaesthesia. However, the use of propofol resulted in less postoperative analgesic consumption and nausea as compared to desflurane.\(^{(6)}\) Loop et al. also confirmed the results of this study and they showed that despite faster early recovery and less need for postoperative analgesic and antiemetic medication, the late recovery was comparable among the remifentanil based desflurane, sevoflurane or propofol groups.\(^{(7)}\)

Fletcher et al. concluded that the use of desflurane was associated with a more rapid initial awakening and less impairment of psychomotor performance. \(^{(8)}\) In addition to shorter emergence times, Ghouri et al. ’s results suggested that the use of desflurane (vs. isoflurane) was associated with less depression of cognitive function during the early postoperative period. In addition, the patients’ subjective feelings of discomfort, drowsiness, fatigue, clumsiness, and confusion were more similar to their baseline values with desflurane as compared to isoflurane. In contrast to this hypothesis, it was suggested that there were only minor differences with regard to recovery phase who received clinically titrated inhalation anaesthesia with desflurane, sevoflurane, or isoflurane. \(^{(9)}\)

The study by Nathanson et al. suggested that sevoflurane and desflurane provided similar intraoperative conditions during the maintenance period. Although early recovery was more rapid after desflurane, there were no difference in later recovery end-points.\(^{(10)}\) Randomised, double-blind study of Tarazi et al. showed that both sevoflurane and desflurane were acceptable inhalational anaesthetics for outpatient tubal ligation surgery.\(^{(11)}\) This study confirmed the previous nonrandomised study of Nathanson et al. in that intermediate recovery and discharge times were comparable. Analogous to the findings in earlier study, Song et al. found that the late recovery profiles and incidences of postoperative side effects were similar after desflurane and sevoflurane. \(^{(12)}\)

Our study also confirms the study of Nathanson et al. but does not confirm Tarazi et al.’s findings that recovery indices and psychomotor functions were marginally but not significantly better with sevoflurane than desflurane. We also found that desflurane offered an transient advantages compared with sevoflurane with respect of early recovery even though the duration of anaesthesia was longer in desflurane group.

Most frequent side effect after surgery was nausea and vomiting in our study. Although the incidence of these symptoms was greatest in the desflurane group, the difference was not statistically significant (p>0.05). This result confirmed the results of many study\(^{(13,14,15)}\)

Intraoperative cardiovascular stability was easily achieved with both sevoflurane and desflurane, with MAP and HR maintained within ± 20 % of baseline values during the maintenance period. Although HR decreased below baseline levels, the reduction was less in desflurane group.

In conclusion, desflurane, like sevoflurane, maintains haemodynamic stability during intraoperative period. Although the duration of anaesthesia was longer, early recovery profile was rapid in desflurane group. The difference between late recoveries was comparable between groups.

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