Inhaled Desflurane vs. Propofol for Postoperative Sedation Guided with Patient State Index of SEDline in Mechanically Ventilated Liver Transplant Recipient

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Abstract

Background: Monitoring sedation depth with appropriate sedative choice can reduce over sedation and associated side effects.

Objectives: To compare Desflurane (Des) vs. Propofol (P) sedation with regards to, haemodynamics, recovery profiles, side effects and costs.

Design: A prospective randomized hospital based comparative study.

Setting: In a single centre between May 2012 and December 2014.

Patients: Sixty mechanically ventilated liver recipients were assigned randomly to receive postoperative sedation either with inhalational Des in air/oxygen 1 litre min-1 or intravenous P 4 mg/kg/hr.

Interventions: Recovery time and response to eye opening was recorded. Memorization of five words, Trieger dot test, and digit symbol substitution tests were applied. The Patient State Index (PSI) by SEDLine Sedation Monitoring Monitor (Masimo, Irvin, CA) was used to target adequate depth of sedation (50-75) in both groups. Ramsay sedation score (RSS) was monitored. Fentanyl was used to assist sedation guided with PSI. The Transesophageal Doppler (TED) was recorded hourly; corrected flow time (FTc) of TED was used for fluid optimization.

Main outcome measures: Recovery profile was the primary end point. Secondary outcomes were haemodynamic events, side effects and cost.

Results: Recovery was faster with Desflurane than Propofol (2.0±1.1 vs. 13.1±4.4 min, P<0.01, respectively) regarding eye opening (PSI>75), five words recall, Trieger dot test and digit symbol substitution test. Required duration of sedation was lower with Desflurane (6.83±2.00 vs. 8.26±1.68 hour, P=0.004). Systemic vascular resistance (SVR) and mean arterial blood pressure (MABP) were better maintained with Desflurane. Under comparable PSI readings between both groups at all measuring points (SVR, MABP and PSI after 2hrs sedation 908.93±139.5 vs. 617.6±104.5 dyn.sec.cm⁻³, P<0.01 and 77.0±3.8 vs. 63.4±6.3 mmHg, P<0.01, 63.30±6.374 vs. 62.2±5.8, P=0.517 respectively), in contrast the mean RSS was consistently higher with Des compared to P, Ps<0.01 at all times. Less norepinephrine was required with Des (n=10) (33.3%) compared to P (n=23) (76.7%), (P<0.001). Ventilation duration shortened with Des vs, P (6.83±2.00 vs. 8.26±1.68 hour, P=0.004) with comparable arterial blood gases at start (P>0.01). Fentanyl was frequently combined with P to reduce its effect on SVR and MBP. (483.3±168.3 vs. 100±0.00 µg, P=0.05). Total consumption of Des and P were (53.13±10.30 ml vs. 1010.33±205.06 mg). Cost was lower with Desflurane (0.9±0.3 vs. 1.6±0.4) Sterling £/hour, (P=0.000).

Conclusion: Postoperative Desflurane sedation guided with PSI enhanced recovery at a lower cost when compared to Propofol as well as preserving better the haemodynamics at a lower cost.

Keywords: Sedation; Liver transplantation; Propofol; Desflurane

Introduction

In the immediate postoperative period liver transplant recipients can require mechanical ventilation. An adequate level of sedation without over sedation is of significant importance for recipients with newly transplanted liver grafts and with anticipated haemodynamic and metabolic changes as a consequence of the procedure itself and of the graft performance. Careful drug choice with adequate sedative depth monitoring and analgesia can help reduce the unwanted side effects, and improve related morbidity and mortality with an enhancement in recovery [1].

In the immediate immediate post-liver transplant procedure management focuses on haemodynamic stability, protection of the newly transplanted graft from haemodynamic changes, as well as...
enhancing the weaning from mechanical support as early as possible. Propofol is commonly used for the sedation of patients in need for mechanical ventilation. Although, Propofol has been established as a safe and effective drug for the sedation of patients in the intensive care units, it’s administration for liver transplant recipients has to be carefully monitored as most of these recipients suffer from a reduced systemic vascular resistance as a consequence of their long standing end stage liver disease [2].

Desflurane is one of the third generation inhaled anaesthetics. It is the halogenated inhaled anaesthetic with the lowest blood and tissue solubility’s, which promotes its rapid equilibration and its rapid elimination following cessation of administration. Its benefits include rapid and predictable emergence and early recovery. In addition, the use of Desflurane promotes early and predictable extubation, which has a positive impact on patient turnover [3].

The aim of this study is to compare patient state index guided sedation with Propofol vs. Desflurane in mechanically ventilated adult living donor liver transplant recipients during their immediate postoperative period regarding their haemodynamics, sedation and recovery as well as cost.

Patients and Methods

Ethics

In this prospective hospital based randomized control study, a written informed consent and Institutional Research and Ethics Committee approval from National Liver Institute, Menoufiya University, Egypt (0070/2013, Chairperson Prof. Mohamed El Guindi) were obtained. The study was registered at the Cochrane research data base of South Africa (PACTR 201402000758402), (www.pactr.org).

Patients, groups and randomization

Sixty living donor liver recipients were categorized randomly using a simple random technique (closed envelopes) into two equal groups, for postoperative sedation either by Desflurane inhalation (group D) or Propofol infusion (group P). Inclusion criteria: written and informed consent , age 18–60 year, Model for End-Stage Liver Disease (MELD) score between 12-20, and living donor liver transplant (Crane House, Molly Millars Lane, Wokingham, UK) was used for each patient and PEEP was set to 5 cm H2O.

Desflurane was delivered (in group D) by a modified TEC-6 vaporor (Dräger Medical, Lubeck, Germany). Ventilator offers synchronized intermittent mandatory ventilation. Fresh Soda Lime (Crane House, Molly Millars Lane, Wokingham, UK) was used for each patient and PEEP was set to 5 cm H2O.

Desflurane was delivered (in group D) by a modified TEC-6 vaporor (Dräger Medical). End-tidal concentration of 3 vol. % was used initially, and this could be changed in steps of up to 0.5 vol. %.

Ventilation was adjusted to maintain the PaCO2 between 35-40 mmHg and the PaO2 between 100 and 150 mmHg. End-tidal Desflurane and carbon dioxide concentrations were monitored by side-stream infrared spectroscopy.

In group P, Propofol infusions (range 0.5-6 mg/kg/h) were titrated to response guided by patient state index. Bolus doses of Propofol 40 mg were allowed.

In both groups, if there was a need for additive analgesia, Fentanyl was given and the requirements were recorded. The study drugs were adjusted to achieve target patient state index (PSI) of 50-75.

Before extubation study drugs were hold, and patients were addressed by their names, asked to open their eyes and to squeeze their hands.

Anaesthetic technique

After standard monitoring was in place, general anaesthesia was induced with intravenous (IV) Propofol 2 mg/kg with anaesthesia depth monitoring in place, Fentanyl 1 µg/kg and rocuronium 0.6-0.9 mg/kg followed by endotracheal intubation.

Anaesthesia was maintained with (Desflurane) in O2/Air mixture (FiO2=0.4) rocuronium and fentanyl to keep Patient State Index (PSI) between 25-50 (SEDLine, Masimo, Irvine, CA, USA) to monitor and achieve surgical anaesthesia. Transesophageal Doppler probe (CardioQ Deltex Medical, Chichester, UK) was inserted via oral airway and used to monitor and measure haemodynamic variables.

Normothermia was achieved with a forced-air warming device. An arterial line was placed in the left radial artery, and central line was inserted in the right internal jugular vein with triple lumen catheter and large-bore single lumen catheter 7.5F.

Fluid regimen consisted of Ringer acetate solutions at 6 ml/kg/h. Albumin 5% was given only to treat hypoalbuminaemia. Packed red blood cells were transfused to keep haematocrit above 25%. Other blood products were administered under guidance of Rotational Thromboelastometry (ROTEM). Hypervolemia was treated with bolus of colloid 5 ml/kg (130/0.4 Hydroxy ethyl statch (Vouven), Fresenius, Kabli). Boluses of colloid (maximum dose, 30 ml/kg) were administered, guided by an algorithm depending on the Doppler estimations of stroke volume and corrected flow time (FTc). This algorithm was similar to that used by Sinclair et al. [4].

Study protocol

At the end of surgery, patients were allocated randomly for sedation with either Desflurane (Group D) (Baxter,Erlangen, Germany) or Propofol (Group P). (Diprivan, Astra-Zeneca, Wedel, Germany). The study observation period started from arrival at the ICU to 2 hrs. post tracheal extubation.

Monitoring level of sedation was achieved by patient state index of the SEDLine Brain Function Monitor (Masimo, Irvine, CA, USA). Patients were monitored to assess the sedation status according to the Ramsay scale and keep the patient state index (PSI) between 50-75 hourly. All patients were ventilated with an anaesthesia ventilator (Cicero, Drager Medical, Lubeck, Germany). Ventilator offers synchronized intermittent mandatory ventilation. Fresh Soda Lime (Cran House, Molly Millars Lane, Wokingham, UK) was used for each patient and PEEP was set to 5 cm H2O.

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Measurements

Preoperative data: Includes baseline score of five-word memory test, trigger's dot test and digit symbol substitution test.

Operative data include: Start time, end time and duration of operation (h), Volatile anesthetic (Desflurane) consumption (ml), Dosage of used opioids as Fentanyl (µg), Final core temperature (°C) and red blood cell transfusion requirements (units).

Postoperative data: Were monitored continuously from arrival at the intensive therapy unit until 2 h after tracheal extubation.
This includes: (1) Haemodynamic data; heart rate (HR), mean arterial blood pressure and transesophageal doppler parameters (cardiac output (COP), systemic vascular resistance (SVR) and corrected flow time (FTc). (2) An assessment of the sedation status according to both Ramsay Sedation scale and Patient State Index. (3) The Sedation profile; duration of sedation (hrs.), dosage and of additive analgesic drugs, as Fentanyl (µg), dosage of study drugs; Desflurane (ml) and Propofol (mg/kg), the consumption of vasoactive drugs in both groups and the time from cessation of sedation to extubation was recorded in minutes. (4) The recovery profile; Time to early emergence (defined as verbal command responses [eye opening, hand squeezing], tracheal extubation, and orientation (defined as providing correct date of birth) and Psychometric tests; five-word memory test, Trigger's dot test and Digit symbol substitution test. (5) Side effects as nausea, vomiting, and agitation. (6) Total cost in both groups was calculated according to the British National Formula announced prices (www.bnf.org).

Statistical analysis

**Design:** Non-blinded randomized prospective hospital based comparative study. In the present study α was set to 0.05, and maximum b accepted=20% with a minimum power of the study of 80% [5]. Primary outcome of this RCT is SVR with S.D. of 100 to 120, the effect size in SVR was set to 200, which resulted in a recommended sample size of 30 per group. Calculation of sample size was done using IBM SPSS Sample power) software and was also confirmed using length Java Applets for Power and Sample Size (Computer software). Multiple samples will be normally-distributed, even if the source population is not normally-distributed, provided that the sample size is large enough (30 or more), so all variable included in the study considered to be normally distribution and parametric statistics were carried out.

- Exploration of the data: This yielded complete descriptive statistics including the minimum and maximum, range, mean, median and inter-quartile range for each variable.
- Data were described using minimum, maximum, mean and standard deviation.
- Comparisons were carried out between the two studied groups using independent t test (t test).
- Box and Whiskers graphs were carried out.
- Chi-square test and Fisher exact test will be used to measure association between qualitative variables.

Correction of P value for multiple testing was set Pt0 to 0.01 to detect significant correlation (Bonferroni correction of multiple comparisons). So in the present study an alpha level was designed to 1% with a significance level of 99%, and a beta error accepted up to 20% with a power of study of 80%.

Results

A total of 63 patients were included, 2 patients were excluded due to haemodynamic instability during the immediate postoperative period and one due to relatives refusal. 60 recipients were randomized. 30 patients had been allocated to group Des and 30 to group P.

In Table 1 patients' characteristics of both groups, model of end stage liver disease (MELD), sex distribution, duration of operation, amount of blood loss, packed red blood cells transfusion requirements and total consumption of Fentanyl were comparable (P value>0.01).

**Table 1:** Patient characteristics.

Postoperatively, the mean duration of sedation was significantly shorter in Desflurane group (6.83 ± 2.00 hrs.) compared to Propofol group (8.26 ± 1.68 hrs.) (P value<0.01).

Regarding the mean blood pressure, there were no statistically significant differences between both groups at T0, P value>0.01 but a statistically highly significant differences at T1, T2, P value<0.01 was observed as presented in Figure 1.

As well as after extubation at T1, T2, P value>0.01 but statistically highly significant differences were present at T1, T2, P value<0.01 Figure 2.

Both TED measured cardiac output and corrected flow time was comparable between both groups P>0.01.

The number of patients in need for catecholamine support (norepinephrine) were lower in Desflurane group (n=10) (33.3%) compared to Propofol group (n=23) (76.7%), P<0.01 Table 2.

No statistically significant differences between both groups regarding the patient state index as presented in Figure 3.

Mean values of Ramsay sedation scores were significantly lower in Propofol group compared to Desflurane group, P<0.01, starting from T1 and afterwards Table 3.
Changes overtime in mean arterial blood pressure (MBP) in both groups. T0, MBP before drug administration; T1-T11, MBP every hour till extubation; T1A.E, T2A.E, MBP one & two hours after extubation; *, significant (P<0.01).

Changes overtime in systemic vascular resistance (SVR) in both groups. T0, SVR before drug administration; T1-T11, SVR every hour till extubation; *, significant (P<0.01).

Psychometric tests: Five wards memory test showed statistically significant difference between both groups at T1 (one minute after extubation) P<0.01.

Both Triegar’s dot test and Digit symbol substitution test also showed statistically highly significant difference at T60, (60 minute after extubation), (P value<0.01).

Nausea, vomiting, agitation and drowsiness were higher in number with in the Propofol group compared to the Desflurane group, P<0.01, while hypertension was reported once in the Desflurane group (n=1) (3.3%) compared to Propofol group (n=0) (0.0%).

Regarding mean sedation cost/hr. (£) in Sterling pounds was (0.985±0.332) with in the Desflurane group vs. (1.618±0.456) in Propofol group, P value<0.01.

Time from cessation of the study drug to eye opening (min), to hand squeezing (min), to verbal command (min) and to extubation were significantly shorter in Desflurane group than Propofol group, P<0.01 Table 4.

Discussion

The results of this current study demonstrated that recipients sedated with Desflurane preserved better their mean arterial blood pressure and systemic vascular resistance at all points of measurements during the period of mechanical ventilation and for two hours after extubation compared to the Propofol sedated group without causing any significant difference in cardiac output or heart rate between the two groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Norepinephrine</th>
<th>Frequency</th>
<th>Percent</th>
<th>X² test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Yes</td>
<td>23</td>
<td>76.7%</td>
<td>11.380</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>7</td>
<td>23.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Yes</td>
<td>10</td>
<td>33.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>20</td>
<td>66.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Catecholamine (norepinephrine) support need differences between Propofol group (P) and Desflurane group (D).
Several studies have explained these findings as the Propofol may lead to a reduction in the systemic vascular resistance, this Propofol induced hypotension is thought to be mediated by inhibiting the sympathetic nervous system and impairing the baroreflex regulatory mechanism, in addition Propofol is considered to have a direct relaxing effect on venous smooth muscles with an increase in venous capacitance which may contribute to the hypotension [6,7].

Similar results to our study were reported by Zahoor A and his colleagues [5]. They observed no change or decrease in the heart rate after a bolus or infusion of Propofol, in contrast, low concentrations may completely depress consciousness in SVR due to its peripheral vasodilating effect, which was aggravated in cirrhotic patients already prone to peripheral vasodilation [10].

In this current study it was also noticed that the duration of required mechanical ventilation for liver transplant recipients was significantly longer for those receiving Propofol compared to patients receiving Desflurane. This can be partially explained by the rapid reversal of the sedating effect of Desflurane due to its pharmacokinetic properties. Minimal effects of Desflurane on circulation and cardiac performance lead to reduced demand for catecholamine support which preferable to be reduced prior to weaning from ventilator support, this helped in fulfilling the criteria for earlier extubation.

Kollef et al. [11] concluded in their study that the strategies targeted at reducing the use of continuous intravenous sedation could shorten the duration of mechanical ventilation for some patients.

It was also noticed that the mean dosage of additive sedative drug (Fentanyl) was lower in the Desflurane group than in the Propofol group. The haemodynamic changes after liver transplantation and the vasodilating effect of Propofol necessity the use Fentanyl to reduce the required Propofol dosage to achieve the targeted sedative effect while reducing the Propofol expected effect on MABP and SVR. Desflurane

### Table 3: Patient State Index (PSI) and Ramsay Sedation Score (RSS).

<table>
<thead>
<tr>
<th>Measuring time</th>
<th>Groups</th>
<th>Min-max</th>
<th>Mean ± SD</th>
<th>t- test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>To eye opening (min)</td>
<td>P</td>
<td>8.00-20.00</td>
<td>13.16 ± 4.472</td>
<td>13.175</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>0.25-5.00</td>
<td>2.07 ± 1.125</td>
<td>13.175</td>
<td>0.000*</td>
</tr>
<tr>
<td>To hand squeezing (min)</td>
<td>P</td>
<td>13.00-25.00</td>
<td>17.56 ± 4.903</td>
<td>15.442</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>0.50-6.00</td>
<td>2.98 ± 1.642</td>
<td>15.442</td>
<td>0.000*</td>
</tr>
<tr>
<td>Till verbal command (min)</td>
<td>P</td>
<td>15.00-45.00</td>
<td>22.60 ± 7.327</td>
<td>8.039</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>0.50-6.00</td>
<td>3.45 ± 1.656</td>
<td>8.039</td>
<td>0.000*</td>
</tr>
<tr>
<td>To extubation (min)</td>
<td>P</td>
<td>18.00-90.00</td>
<td>36.03 ± 18.214</td>
<td>13.213</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>3.00-15.00</td>
<td>8.93 ± 3.027</td>
<td>13.213</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

### Table 4: Time from cessation of drug to different parameters in the two study groups.

<table>
<thead>
<tr>
<th>T&lt;sub&gt;0&lt;/sub&gt;</th>
<th>T&lt;sub&gt;2&lt;/sub&gt;</th>
<th>T&lt;sub&gt;4&lt;/sub&gt;</th>
<th>T&lt;sub&gt;8&lt;/sub&gt;</th>
<th>T&lt;sub&gt;B&lt;/sub&gt;</th>
<th>T&lt;sub&gt;10&lt;/sub&gt;</th>
<th>T&lt;sub&gt;11&lt;/sub&gt;</th>
<th>T&lt;sub&gt;1A.E&lt;/sub&gt;</th>
<th>T&lt;sub&gt;2A.E&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient State Index (PSI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group P</td>
<td>68.90 ± 7.674</td>
<td>63.30 ± 6.374</td>
<td>67.00 ± 5.842</td>
<td>65.64 ± 7.568</td>
<td>69.08 ± 6.067</td>
<td>68.63 ± 4.388</td>
<td>67.55 ± 4.390</td>
<td>93.40 ± 4.568</td>
</tr>
<tr>
<td>Group D</td>
<td>69.90 ± 7.544</td>
<td>63.30 ± 6.374</td>
<td>65.03 ± 5.726</td>
<td>64.76 ± 6.998</td>
<td>65.60 ± 7.209</td>
<td>68.16 ± 3.188</td>
<td>70.40 ± 1.140</td>
<td>92.33 ± 4.603</td>
</tr>
<tr>
<td>P value</td>
<td>0.349</td>
<td>0.517</td>
<td>0.193</td>
<td>0.662</td>
<td>0.117</td>
<td>0.821</td>
<td>0.187</td>
<td>0.371</td>
</tr>
</tbody>
</table>

Ramsay Sedation Score (RSS)

| Group P      | 4.46 ± 0.507 | 4.53 ± 0.507 | 4.63 ± 0.490 | 4.42 ± 0.572 | 4.47 ± 0.510 | 4.63 ± 0.504 | 4.33 ± 0.500 |
| Group D      | 4.46 ± 0.507 | 5.63 ± 0.490 | 5.53 ± 0.507 | 5.61 ± 0.571 | 5.66 ± 0.487 | 5.50 ± 0.547 | 5.60 ± 0.547 |
| P value      | 0.117         | 0.000*        | 0.000*        | 0.000*        | 0.000*        | 0.005*        | 0.001*        |

Data were presented as mean ± SD, tested by student t-test, P-value<0.01 statistically significant. T<sub>0</sub>: PSIand RSS before drug administration. T<sub>2</sub>-T<sub>11</sub>: PSIand RSS every hour till extubation. T<sub>1A.E</sub>-T<sub>2A.E</sub>: PSI one& two hours after extubation. SD: standard deviation
was not in need for any supplantations in this context due to it
minimal haemodynamic effects in comparison to Propofol.

The need for analgesics in the current study is the Desflurane group
was minimal in general. Several studies explained why liver transplant
recipients are less in need for analgesics than other non-hepatic
patients undergoing surgery. The changes in the level of endogenous
neuropeptides, such as, beta-endorphins, meta-enkephalins, and
substance P are thought to be playing a part in reducing their
requirements for intravenous opioids and even general anaesthetics,
their levels are directly proportionate with the severity of liver disease
and are reported to be higher in end stage liver disease patients [12,13].
Fentanyl was used more frequently in this study with Propofol to
reduce its haemodynamic side effects.

All measured emergence times (defined as verbal command
responses [eye opening, hand squeezing] tracheal extubation, and
orientation (defined as providing correct date of birth) were more
prolonged in Propofol group than in Desflurane group, this may be
due to the peculiar nature of Desflurane which enjoys a low blood/gas
solubility coefficient and low metabolic rate which can reach to 0.02%
(the lowest in vivo metabolism of any available inhaled halogenated
anaesthetics). Lendvay et al. [14] reported faster recovery with
Desflurane anesthesia when compared with other intravenous
anesthesia.

Similarly, Wachtel et al. [15] published a meta-analysis of average
times and variability in times of extubation and following commands
after Desflurane or Propofol anaesthesia. Their analysis showed
distinct differences in favour of Desflurane.

In addition, the quick emergence times are indicators of greater
control of sedation. If the level of sedation needs to be increased to
perform unpleasant or painful procedures in the ICU, this can be
achieved quickly by Desflurane. After the end of the procedure, the
previous level of sedation may be restored immediately [16].

One of the limitations of our study was not using the Remifentanil
instead of Fentanyl. Remifentanil seems to be the ideal partner for
control of sedation. If the level of sedation needs to be increased to
anesthesia. Lendvay et al. [14] reported faster recovery with
Desflurane anesthesia when compared with other intravenous

In conclusion Des sedation guided with PSI preserved better the
psychometric performance as many patients, in spite of being mentally competent, were not able to execute the tests
because of weakness, tremor, swollen hands, impaired vision (oedema
of the conjunctiva or upper eye lids) and inability to sit up.

A frequently discussed adverse reaction to Desflurane is
sympathetic hyperactivity [3]. Interestingly, in our study there wasn’t
any episode of tachycardia or hypertension attributable to an increase
in Desflurane concentration probably because we never used more
than 4 vol % Desflurane.

Ebert et al. [18] explained our finding that sympathetic activation
only occurs when abruptly increasing the Desflurane concentration
from 1 MAC (minimum alveolar concentration) (7.25 vol %) to 1.5
MAC (11 vol %), but not from 0.5 to 1 MAC.

In contrast, Ramsay scores were higher (more deeply sedated) in
Desflurane group than in Propofol group. As an explanation, it is
assumed that volatile anaesthetics may act like an on-off switch for
consciousness, whereas with Propofol it may be easier to achieve
intermediate levels of sedation as reported by Meiser et al. [16].

Similarly, Meiser et al. [19], in a study among surgical intensive care
patients receiving Propofol and Sufentanil, found the PSI to be highly
predictive of the depth of sedation in mechanically ventilated patients.
The PSI values showed significant differences between different levels
of sedation as measured by the Ramsay sedation score (RSS).

A prospective blinded study of mixed ICU patients by Ramsay et al.
[20] also found a strong correlation between the PSI and the RSS.
Similarly in another study by Sessler et al. [21] investigating the
relationship between PSI and the sedation/agitation level measured by
Richmond Agitation-Sedation Scale score found significant
associations between PSI and Richmond Agitation-Sedation Scale to
support the validity of the PSI as a tool to monitor the level of sedation
in the Intensive care Unit.

Higher costs for the Propofol group compared to the Desflurane
group, this could be due to the low flow circuit used during Desflurane
administration and the high dose of Propofol and Fentanyl consumed.

Similarly, Meiser et al. [16] showed that inhaled anaesthesia was
associated with a lower cost when compared with the Propofol-based
sedation.

No technical difficulties or problems in the use of the anaesthesia
ventilator or the Desflurane vaporizer were reported in the Intensive
Care. Anaesthesia Machines were equipped with a scavenging system
using charcoal adsorption.

Sackey et al. [22] demonstrate that the occupational load from the
volatile anaesthetic, in the presence of anaesthetic gas scavenging
system at the bedside, is minimal and within the international standard
(mean of 0.1 ppm), using isoflurane.

In conclusion Des sedation guided with PSI preserved better the
haemodynamic parameters, enhanced recovery at a lower cost
compared to Propofol. Patient state index (PSI) was able to provide a
consistent and comparable depth of sedation with two different
sedative drugs as Des and P in contrast to Ramsay sedation score
(RSS). Further multicenter studies on a larger scale are recommended.

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Conflict of Interest

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References
