

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

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Received Date: December 16, 2015; Accepted Date: April 16, 2016; Published Date: May 02, 2016

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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 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⁻⁵, $P<0.01$ 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, $P<0.01$ 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, its 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 recipients planned for weaning of ventilation normoxia, normothermia with no major intraoperative events. Exclusion criteria: severe haemodynamic instability at the end of the operation, patients in need for re-operation and unwilling to participate in the study.

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 starch (Vouluven), Fresenius, Kabi). 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, 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 vaporisor (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.

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-blind randomized prospective hospital based comparative study. In the present study α was set to 0.05, and maximum β 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 *P* 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).

	Propofol group (n=30)	Desflurane Group(n=30)	(P-value)
Age (yrs.)	43.70 ± 6.94	42.60 ± 8.18	0.577
Weight (kg.)	78.73 ± 8.58	78.13 ± 8.36	0.785
Height (cm.)	172.70 ± 6.22	170.16 ± 4.80	0.083
BMI	26.89 ± 2.73	26.63 ± 1.92	0.672
MELD Score	14.20 ± 1.90	14.36 ± 1.35	0.697
Males [n (%)]	26 (66.7%)	24 (80.0%)	0.488
Females [n (%)]	4 (13.3%)	6 (20.0%)	
Duration of surgery (hr.)	14.35 ± 1.86	14.78 ± 2.29	0.425
Blood loss (cc.)	1816.66 ± 1075.45	1883.33 ± 801.32	0.786
Dosage of Fentanyl (µg.)	1263.33 ± 403.84	1190.00 ± 325.20	0.442
Final core temperature (°C)	36.53 ± 0.39	36.57 ± 0.48	0.705
Packed RBCS transfused	6.43 ± 4.93	5.93 ± 4.19	0.674
Data are shown as mean ± standard deviation (mean ± SD)			

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 T_0 , *P* value>0.01 but a statistically highly significant differences at T_1 - T_{11} , *P* value<0.01 was observed as presented in Figure 1.

As well as after extubation at $T_{1A,E}$ (82.46 ± 7.015) and $T_{2A,E}$ (83.20 ± 6.920) in Desflurane group vs. $T_{1A,E}$ (73.46 ± 4.297) and $T_{2A,E}$ (73.96 ± 3.011) in Propofol group, *P* value<0.01.

Regarding Transesophageal Doppler measured systemic vascular resistance, there were no statistically significant differences between both groups at T_0 , *P* value>0.01 but statistically highly significant differences was present at T_1 - T_{11} , (*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 T_1 and afterwards Table 3.

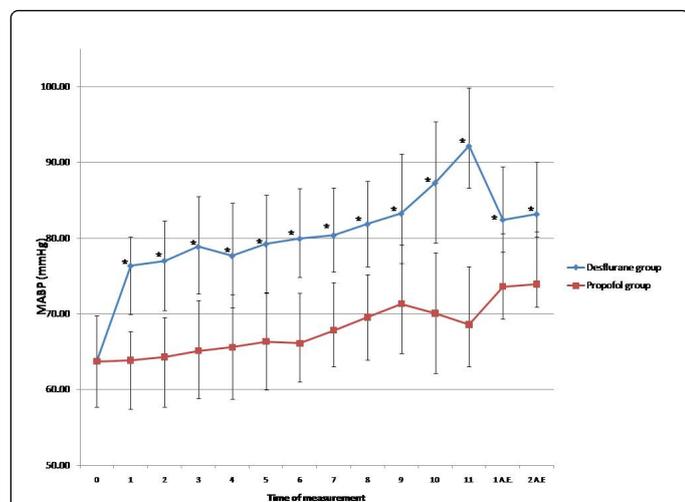


Figure 1: Changes overtime in mean arterial blood pressure (MBP) in both groups. T₀, MBP before drug administration; T₁-T₁₁, MBP every hour till extubation; T_{1A.E}, T_{2A.E}, MBP one & two hours after extubation; *, significant (P<0.01).

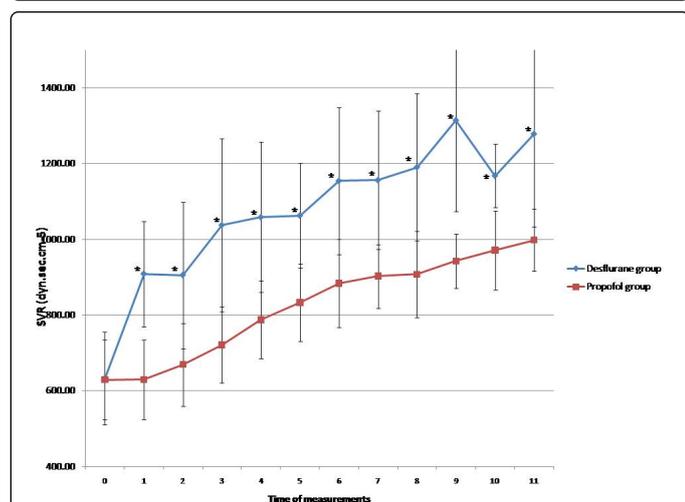


Figure 2: Changes overtime in systemic vascular resistance (SVR) in both groups. T₀, SVR before drug administration; T₁-T₁₁, SVR every hour till extubation; *, significant (P<0.01).

Psychometric tests; Five words 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.

Groups	Norepinephrine	Frequency	Percent	X ² test	P- value
P	Yes	23	76.7%	11.380	0.001*
	No	7	23.3 %		
	Total	30	100%		
D	Yes	10	33.3%	11.380	0.001*
	No	20	66.7		
	Total	30	100		

Table 2: Catecholamine (norepinephrine) support need differences between Propofol group (P) and Desflurane group (D).

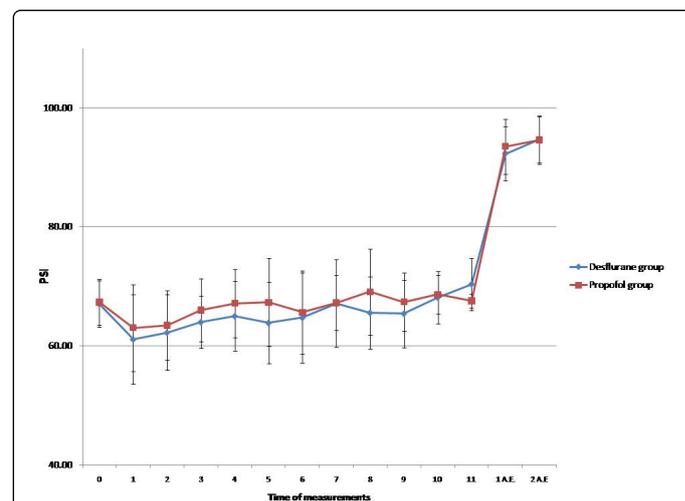


Figure 3: Changes overtime in Patient State Index in both groups. T₀, PSI before drug administration; T₁-T₁₁, PSI every hour till extubation; T_{1A.E}, T_{2A.E}, PSI one & two hours after extubation significant (P<0.01).

	T ₀	T ₂	T ₄	T ₆	T ₈	T ₁₀	T ₁₁	T _{1A,E}	T _{2A,E}
Patient State Index (PSI)									
Group P	68.90 ± 7.674	63.30 ± 6.374	67.00 ± 5.842	65.64 ± 7.568	69.08 ± 6.067	68.63 ± 4.388	67.55 ± 4.390	93.40 ± 4.568	94.50 ± 3.892
Group D	69.90 ± 7.544	63.30 ± 6.374	65.03 ± 5.726	64.76 ± 6.998	65.60 ± 7.209	68.16 ± 3.188	70.40 ± 1.140	92.33 ± 4.603	94.73 ± 4.067
P value	0.349	0.517	0.193	0.662	0.117	0.821	0.187	0.371	0.821
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 ₀ : PSland RSS before drug administration. T ₂ -T ₁₁ : PSland RSS every hour till extubation. T _{1A,E} , T _{2A,E} : PSI one& two hours after extubation. SD: standard deviation									

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

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

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

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 of their patients after a bolus or infusion of Propofol, in contrast, others have observed an initial tachycardia after Propofol administration [8].

Meiser et al. [9] showed that volatile anaesthetics act primarily on the more rostral brain structures like the cerebral cortex, and even at low concentrations may completely depress consciousness (MACawake) while leaving many autonomic functions (such as temperature control, blood pressure regulation or respiration) undisturbed.

The requirements for norepinephrine reported in this study were significantly lower in recipients sedated with Desflurane than with Propofol. Propofol/Fentanyl infusion resulted in a sustained decrease

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 vasodilation 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

was not in need for any supplementations in this context due to its 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 anaesthesia when compared with other intravenous anaesthesia.

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 Remifentanyl instead of Fentanyl. Remifentanyl seems to be the ideal partner for intravenous and inhalational sedation because of its better pharmacokinetics. Like the volatile anaesthetics, remifentanyl will not accumulate even in patients with hepatic or renal insufficiency. Its use for ICU sedation has been described and it has been licensed for ICU sedation for up to 3 days, but unfortunately it is not yet available in the Egyptian market [17].

Interestingly, no patient in our study receiving Desflurane complained of nausea, a finding that contrasts with common experience from the post anaesthesia care unit where up to 30 or even 50% of patients after inhalational anaesthesia will complain of nausea or vomiting [16].

Meiser A et al. [16] compared Desflurane and Propofol for postoperative sedation in intensive care found similar results in their study.

Better cognitive functions were found after sedation with Desflurane. Patients in Desflurane group correctly stated their birth date earlier and were able to recall significantly more words at this time than patients in Propofol group with a better trieger dot test (TT) and digit symbol substitution test (DSST).

In contrast, Meiser A et al. [16] found that the TT and DSST did not detect differences in 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].

Schneider 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.

Acknowledgement

Number for the registry: PACTR201402000758402

Name of registry: South African Cochrane Centre

Conflict of Interest

Study was funded by departmental resources, but SEDLine Sedation Monitor was donated by Masimo, Irvine, CA, USA.

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