Effect of propofol & sevoflurane on jugular bulb oxygen saturation in patients undergoing brain tumor surgery

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Abstract

Introduction: Sevoflurane, and Propofol are widely used for anesthesia during intracranial surgery. All these drugs reduce the cerebral metabolic rate (CMR) for oxygen ($CMRO_2$). In contrast to their similar effect on cerebral metabolism, they have different effects on cerebral blood flow (CBF). Accordingly, the purpose of our study was to determine the jugular bulb venous blood oxygen saturation (SjO_2) as a measure of the flow metabolism ratio under propofol & sevoflurane anesthesia in patients with intracranial mass lesions.

Objectives: To compare the effects of Sevoflurane & Propofol on jugular bulb oxygen saturation with the help of evaluation of arterial and jugular bulb venous blood samples for hemoglobin (Hb), hematocrit, and blood gas analysis using automated blood gas analyzer & Calculation of arterial to jugular bulb venous oxygen content differences ($AJDO_2$).

Materials and Method: The proposed study is being carried out in S.R.N. Hospital associated with M.L.N. Medical College, Allahabad after obtaining clearance from the Ethical Comittee. A total of 40 patients were included in the study, of ASA Grade 1 & 2, who after randomisation were divided into 2 groups of 20 each, receiving Propofol & Sevoflurane respectively.

Statistical Test: Data was analysed using unpaired t test with the help of SPSS software.

Results: Propofol when compared with Sevoflurane, decreased Jugular Bulb Oxygen saturation (SjO_2) & this difference was statistically significant(49.25±6.57 Vs. 55.60±3.33), decreased PjO2(28.9±2.31 VS 33.15±2.08) & increased $AjDO_2$ (6.62±1.70 VS 5.75±0.81) to a more significant level(p value < 0.05).Further details will be discussed later in the presentation.

Conclusion: In conclusion, brain tumor patients under propofol anesthesia, showed SjO_2 and PjO_2 levels that were significantly lower than those in patients under Sevoflurane anesthesia. Thus in brain tumour patients, in the already compromised brain tissue it is advisable to use Sevoflurane for maintenance of anaesthesia so as to preserve the flow metabolism ratio.

Keywords: Propofol, Sevoflurane, Jugular Bulb Oxygen Saturation(SjO_2), Arterial to jugular bulb venous oxygen content difference($AjDO_2$).

Introduction

Jugular bulb venous oxygen saturation (SjO_2) monitoring is currently suggested in patients with severe head trauma as a global measure of the adequacy of the cerebral blood flow (CBF) to brain metabolic requirements. Gibbs[(1)] et al in 1942 first obtained SjO_2 in normal volunteers followed by Datsur[(2)] et al in 1963. In 1945 Gibbs et al also showed that the SjO_2 does not differ in simultaneous sampling of both right and left jugular bulbs.

These physiological data were obtained by direct puncture of the jugular veins without radiological confirmation of the needle's or catheter's tip position. A 14-gauge Hydrocath percutaneous sheath introducer was inserted retrogradely into the right internal jugular vein, Using Seldinger's technique in all patients independent of the side of the brain pathology. Samples were drawn for haemoglobin (Hb), hematocrit, and bloodgas analysis from Jugular bulb venous blood and were analysed immediately by using an automated blood gas analyzer.

Sevoflurane and propofol are widely used for anaesthesia during intracranial surgery. Both these drugs reduce the cerebral metabolic rate (CMR) for oxygen ($CMRO_2$), and the resulting decrease of the cerebral oxygen demand means increased tolerance for a subsequently imposed ischemic insult. In contrast to their identical effect on cerebral metabolism, sevoflurane and propofol have different effects on cerebral blood flow (CBF).Studies have shown that, although sevoflurane reduces $CMRO_2$ dose-dependently[(3-6)] it increases or maintains CBF, thereby possibly producing an increase of the CBF/CMR ratio.

Propofol[7] in contrast, has been reported to reduce CBF in humans. Various studies demonstrated that the decrease in CBF was larger than the decrease in $CMRO_2$, which suggests that propofol might have direct cerebral vasoconstriction activity, which may lead to a decrease of cerebral perfusion & a decrease of the CBF/CMR ratio. The hypothesis of this study was that, during propofol anaesthesia, the brain is relatively hypo-perfused compared with sevoflurane anaesthesia, resulting in a decreased brain oxygen supply and demand ratio.

Thus, the study was designed to determine the jugular bulb venous blood oxygen saturation (SjO_2) as a measure of the flow metabolism ratio under propofol &

sevoflurane anaesthesia in patients with brain tumor surgery.

Materials and Method

The study was completed in 2 year (2013-2015) after the approval from The Ethical Committee of the institution. 40 Adult patients of either sex between age 18 to 60 years, belonging to ASA physical status I-II, posted for elective surgery having normal upper airway were recruited for this study divided into 2 groups 20 of each, after thorough clinical and routine laboratory examinations and obtaining written and informed consent from the patient. A pulse oximeter, non-invasive blood pressure monitor, ABG analyser for monitoring.

The patient was allocated in two groups after randomization technique:

Group P: Patients who are maintained with Inj. Propofol
75-100µg/kg/min

Group S: Patients who are maintained with Sevoflurane 1.5-2%.

Patients included in the study belonged to American society of anesthesiology (ASA) Grade I-II, Mallampati score I-II, Adults (age 18-60 years), Body weight within normal range of BMI, Fasted patients (>6 hours for solid, >2 hours for liquid excluding milk), Elective procedures & Non pregnant patient.

On arrival in operation theatre, venous cannulation was done with 18G cannula and intra venous line was secured, minimum mandatory monitoring were instituted in the form of pulse oximetry (SpO_2), non-invasive blood pressure (NIBP) and electrocardiograph(ECG).Radial artery was also cannulated for the purpose of arterial blood gas analysis.

Cannulation of the Jugular bulb was done before the induction of general anaesthesia in the Operation Theatre. A 14-gauge Hydrocath percutaneous sheath introducer was inserted retrogradely into the right internal jugular vein using Seldinger's technique, in all patients ir-respective of the side of the brain pathology & an awake patient was asked for a sensation in the jaw or ear as the catheter touches the base of the skull, indicating that the tip of the catheter is in the jugular bulb. Then the catheter is pulled back 0.5–1.0 cm so that the catheter doesn't continue to lean on the roof of the jugular bulb. Jugular bulb venous blood samples were drawn at a rate of 2 mL/min (so that there is negligible extra- cerebral contamination) for haemoglobin (Hb), hematocrit, and blood gas analysis and were immediately analyzed using an automated blood gas analyzer before induction of General Anaesthesia & before Extubation.

Patients were Premedicated with Inj midazolam 30µg/kg i.v, & Inj Butorphanol 30µg/kg. Pre-oxygenation with 100% oxygen was done for 3 minutes. Induction was done by Inj Propofol 2-2.5mg/kg i.v till end point when verbal commands are lost. Muscle relaxant for intubation is achieved by Inj vecuronium 0.08-0.1mg/kg i.v. Intubation was Done with cuffed Armoured (Flexo-metallic) endotracheal tube, position of the tube is verified with auscultation and capnpgraphy then tube is fixed with adhesive. Once position is confirmed, start intermittent positive pressure ventilation(IPPV). Maintenance of anaesthesia with Oxygen+Nitrous oxide+Inhalational agent (Sevoflurane /Propofol), based on the group selected +Intermediate acting muscle relaxant of non depolarising type (Vecuronium). Reversal done by Inj Neostigmine (0.05mg/kg)+ Glycopyrolate (0.01mg/kg).

The arterial to jugular bulb venous oxygen content differences ($AJDO_2$) were calculated from the arterial and jugular bulb venous oxygen partial pressure and saturation using the equation:

AJDO2= arterial O2content (CaO2) — jugular bulb venous O2 content(CjO2)

=Hb × 1.34 ×(SpO2 — SjO2) + (0.0031 ×(PaO2 — PjO2)

where SpO2 is arterial oxygen saturation,

SjO2 is jugular bulb venous oxygen saturation, and

PjO2 is the jugular bulb venous oxygen partial pressure

Global hypoperfusion was defined as SjO_2 <50%; ischemia was defined as SjO_2 < 40% and $AJDO_2$ > 9 mL/dL.

Statistical analysis was performed using Microsoft Excel 2010 and statistical software plug-ins. Continuous data was analyzed by student t test. Data are being represented as mean ± SD. Any possible significance has been determined considering it statistically significant if 'p' value of <0.05.

Results

The two groups were similar with respect to demographic data and preoperative measurements & Haemodynamic parameters.

Table 1

	Propofol	**Sevoflurane**
Age(yr)	43.5±10.73	41.7±10.03
weight(kg)	58.15±6.96	57.65± 6.36

Table 2: Comparison of Pulse Rate in both the Groups

	Propofol	**Sevoflurane**
Pre -op	81.73±6.05	80.88±5.26
5 min	95.10±5.79	94.45±6.21
15 min	91.77±6.90	94.98 ±7.20
30 min	91.68 ±11.74	95.97 ±7.01
60 min	88.83±13.78	93.62 ±6.07
120 min	86.17 ±7.78	87.88 ±5.74

Table 3: Comparison of MAP in both the Groups

	Propofol	Sevoflurane
Pre -op	81.73±6.05	80.88±5.26
5 min	95.10±5.79	94.45±6.21
15 min	91.77±6.90	94.98 ±7.20
30 min	91.68 ±11.74	95.97 ±7.01
60 min	88.83±13.78	93.62 ±6.07
120 min	86.17 ±7.78	87.88 ±5.74

Table 4: **Comparison and analysis of Jugular Bulb Oximetry before induction of general anaesthesia**

	Propofol	Sevoflurane
SpO_2(%)	61±3.80	60.45±3.38
PjO_2(mmHg)	38.4±4.83	40.65±2.60
$AjDO_2$ (ml%)	5.35±1.19	5.37±0.68

There is no statistically significant difference in SjO_2, $PjO_{2\&}$ $AjDO_2$before induction of general anaesthesia in both groups (p>0.05).

Table 5: **Comparison and analysis of Jugular Bulb Oximetry before Extubation**

	Propofol	Sevoflurane	p Value (ANOVA)
SjO_2(%)	49.25±6.57	55.60±3.33	0.0001
PjO_2 (mmHg)	28.9±2.31	33.15±2.08	0.0001
$AjDO_2$	6.62±1.70	5.75±0.81	0.0151

There is statistically significant difference in SjO_2, PjO_2 & $AjDO_2$ before extubation in both groups (p>0.05).

Discussion

The main finding of our study in patients with intra-cranial mass lesions is significantly lower SjO_2 and PjO_2 values & higher AJDO2 values during propofol anaesthesia than during Sevoflurane anaesthesia.

SjO_2 in awake healthy humans, ranges between 55% to 75% (mean 62%). SjO_2 reflects the balance between brain oxygen supply and demand and indicates whether or not CBF is sufficient to meet the oxygen demands of the brain tissues.

SjO_2 values < 50% indicate cerebral hypoperfusion, and value < 40% are associated with global cerebral ischemia.

In our study, 6 patients under propofol anesthesia (Table 6) showed SjO_2 < 50%, compatible with relative cerebral hypoperfusion, and 3 of these patients showed

SjO_2 <40% & 2 had $AjDO_2$> 9ml% (Table 7), compatible with cerebral ischemia. Only 1 patient under Sevoflurane anaesthesia had SjO_2< 50%. Thus, the normal SjO_2 in the patients under Sevoflurane anaesthesia does not indicate the absence of regional ischemia, but the low SjO_2 in three patients in the propofol group may be indicative of global ischemia, focal ischemia, or both.

Table 6: **Level of SjO_2 intra-op**

	Propofol	Sevoflurane
>50%	11	19
40-50%	6	1
<40%	3	0

Table 7: **Level of $AjDO_2$ Intra-op**

	Propofol	Sevoflurane
4-7.5ml%	17	20
7.5-9ml%	1	0
>9ml%	2	0

The group maintained with Propofol, had a greater jugular desaturation, this can be due to an increased incidence of hypotension in this group. The reductions in SjO_2 that we observed appear to be independent of changes in MAP, since there was no incidence of significant hypotension during the study period.

A disadvantage of this study protocol is the absence of continuous jugular saturation monitoring. The use of fiberoptic catheters might have allowed us to provide a more complete picture of cerebral blood flow adequacy during the study period

Nandate K1(2008),[8] et al conducted a study on the effect of isoflurane, sevoflurane and propofol on jugular venous bulb oxygen saturation (SjO2) in 21 patients undergoing coronary artery bypass graft surgery (CABG) during and after normothermic cardiopulmonary bypass (CPB). In the propofol group SjO2 values were significantly lower than baseline 1 h after CPB but not the isoflurane or the sevoflurane groups. Furthermore, SjO2 values were found to be higher during CPB in the isoflurane group (P = 0.0081) and significantly lower 6 h after CPB in the sevoflurane group (P = 0.0447) when compared to the propofol group. Thus, we conclude that during propofol anaesthesia, jugular venous desaturation during and after normothermic CPB is more likely, which is also consistent with our study.

Muñoz HR1, et al(2002)[9] studied the effect of N2O on SjO2 during remifentanil-based anaesthesia with concurrent sevoflurane or propofol in 20 adults undergoing brain tumour surgery. Anaesthesia was randomized: Group 1 (n = 10), target-controlled infusion propofol; and Group 2 (n = 10), thiopental 2-3 mg/kg followed by sevoflurane 0.9% end-tidal. Samples from Jugular bulb and arterial blood for gas analysis were withdrawn before surgery and 20 min after the addition of the study gas and with an ETCO2 26-28 mm Hg and mean arterial pressure >90 mm Hg. In the Propofol group it was found that, SjO2 was 50% +/- 10% with nitrogen and 52% +/- 9% with N2O (not significant); in the Sevoflurane group, however, N2O

67% increased SjO2 from 56% +/- 13% to 66% +/- 12% (P < 0.01).Their results are also comparable to our study as the degree of jugular bulb desaturation was more in the propofol group.

Kawano Y1, et al(2004)[10] investigated jugular bulb oxygen saturation (SjO**2)** during propofol and sevoflurane/nitrous oxide anaesthesia under mildly hypothermic conditions. 20 patients undergoing elective craniotomy were randomly divided into group S/N**2** O (sevoflurane/nitrous oxide/fentanyl anaesthesia) or the group P (propofol/fentanyl anaesthesia). Intra-operatively, patients were cooled and tympanic membrane temperature was maintained at 34.5 degrees C. SjO**2** was measured both at normocapnia and at hypocapnia during mild hypothermia.

During mild hypothermia, SjO**2** values were significantly lower in group P than in group S/N**2**O. Values of SjO**2** less than 50% under mild hypothermic-hypocapnic conditions was significantly higher in group P than in group S/N**2**O. There results are also comparable to our study as the dip in jugular bulb saturation was more in the Propofol group as compared to sevoflurane group.

Iwata M1, et al. (2008)[11] investigated jugular bulb venous oxygen saturation SjO_2 during OLV under sevoflurane- or propofol-based anaesthesia for lung surgery. Samples from Arterial and jugular bulb blood were measured before OLV, 15 & 30 minutes after OLV & 15 minutes after the termination of OLV. SjO_2 values in both sevoflurane and propofol groups significantly declined during OLV ($p < 0.05$).Values of SjO_2 in the sevoflurane group were higher compared to the propofol group, which is comparable to our study, although SaO_2 values were similar ($p < 0.05$). Significant increase in the incidence of SjO_2<50% during OLV was also observed only in the propofol group (from 7.7% to 26.9%, $p < 0.05$, RR = 3.5; 95% CI 1.29-12.4).

Conclusion

As SjO_2 reflects the balance between brain oxygen supply & demand & indicates whether CBF is sufficient to meet the oxygen demands of the brain tissue, it is seen that under Propofol anaesthesia this ratio is greatly altered in comparison to Sevoflurane. Thus in brain tumour patients, in the already compromised brain tissue it is advisable to use Sevoflurane for maintenance of anaesthesia so as to preserve the flow metabolism ratio.

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