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EFFECT OF PROPOFOL INDUCTION ON MCA FLOW VELOCITIES IN PATIENTS WITH INTRACRANIAL SPACE OCCUPYING LESION

Anaesthesiology

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ABSTRACT

The objective was to quantify the effect of intravenous (i.v) propofol on middle cerebral artery flow velocities (MCA-FV) and its derived parameters in patients undergoing surgery for intracranial tumors. Forty patients aged between 15 to 70 years, of either sex, received 1 to 2.5 mg/kg i.v. propofol during induction of anaesthesia. Pulse rate, mean arterial pressures, end tidal carbon dioxide and FV on the non-tumour side (peak systolic, diastolic and mean) were measured at preinduction, and at 1, 3, 5, 10 and 30 min after induction. The pulsatility (PI) and resistivity (RI) indices and transient hyperemic response ratio (THHR) were derived and compared with their preinduction values. Propofol induced a fall in MCA-FV for peak systolic velocities (26.6%) and a diastolic velocities (38%) increase in PI (14.2%), with no significant change in RI. THHR ranged from 1.38 preinduction to 1.31 post induction. Hence propofol decreases FV without affecting cerebral autoregulation.

KEYWORDS:

Transcranial Doppler, Middle cerebral artery, Flow velocity, Pulsatility index, Resistivity index

Introduction:

Brain tumors are second only to stroke as a cause of death from neurologic disease. The age-adjusted incidence rate is 6.5 per 100,000 men and women per year.[1] Almost all patients with intracranial tumors have raised Intracranial pressure (ICP) and 2% of patients with brain tumors bleed spontaneously. Exclusive issues related to induction of anaesthesia for craniotomy are intracranial pressure (ICP) changes in the case of mass lesions and avoidance of hemorrhage in the cases of vascular lesions. The question that which anaesthetic agents are appropriate, especially in the context of unstable ICP, arises often. Anesthetic agents cause functional alterations in the central nervous system and produce metabolic changes. In general, intravenous anesthetics decrease cerebral metabolic rate (CMR) and cerebral blood flow (CBF) in parallel fashion, whereas most inhalational anesthetics decrease CMR with an increase in CBF.[2] The coupling of CMR and CBF is better maintained with intravenous anesthetics, whereas it is lost with inhalational anesthetics at high concentrations. Propofol is an excellent agent for neuroanaesthesia. Previous research has demonstrated its neuroprotective effects on ICP, CBF and CMR.[3] Transcranial Doppler (TCD) Ultrasonography is a real-time, non-invasive technique which allows us to observe velocity, direction and properties of blood flow in the cerebral arteries by means of a pulsed ultrasonic beam. It has widely been used to investigate cerebral blood flow velocity and indirectly, changes in cerebral blood flow. The aim of this study was to study the effect of propofol induction on middle cerebral artery flow velocities, its derived parameters and on cerebral autoregulation during induction of general anaesthesia, in patients with intracranial space occupying lesion, using Transcranial Doppler Ultrasonography.

Methods:

This is a prospective study, conducted over a period of two years between July 2011 to June 2013. For a power of the study of 0.8 (α = 0.05, β = 0.19), 40 ASA class 1 and 2 neurosurgical patients of either sex, aged 15 to 65 years, with unilateral intracranial space occupying lesion and no previous history of radiotherapy were included in our study. Patients with bilateral lesion, revision surgery history of stroke, carotid stenosis, meningitis, and intracranial bleed, cardiac, pulmonary, endocrine or renal disease were excluded from our study.

The RIMED DIGI-LITE Transcranial Doppler system (software version 1.17.5.2) was used to insonate the middle cerebral artery on the non-tumor side. The 2MHz hand held ultrasound probe was placed in the temporal window. TCD signals of the MCA once obtained were verified by a brief compression of the ipsilateral common carotid artery. The signal was traced till the internal carotid artery bifurcation at a depth of approx. 60–65 mm. The depth of insonation was then reduced to find the proximal portion of the MCA trunk. MCA flow velocities obtained at depth 45 to 55mm were included in the study.

Cerebral autoregulation was measured by Giller's transient hyperemic response (THR) test. For this the MCA systolic velocities were measured for five heart cycles ending with the one preceding carotid compression. The mean value of systolic peaks from these five heart cycles was denoted (FV1). The ipsilateral common carotid artery was compressed for 5 to 9 seconds. The MCA systolic velocities of two heart cycles after release of compression, excluding the first cycle, were recorded and their mean was denoted (FV3). **(Figure 5)**.The transient hyperemic response ratio (THRR) is a quantitative index to evaluate the autoregulation state. It is defined as the ratio (FV3)/(FV1).[5]

After taking an informed written consent, the baseline clinical and TCD parameters were recorded and the baseline autoregulation test performed. Patients received premedication with midazolam IV, opioid analgesia with butorphanol 0.03mg/kg IV and induction of anaesthesia was done with IV. Propofol 1 to 2.5 mg/kg in titrated doses. Vecuronium bromide 0.1mg/kg was used for muscle relaxation. The end point of induction was loss of verbal contact with the patient. At 3 min of injection of muscle relaxant, each patient was intubated and given an air-oxygen mixture and maintenance dose of IV anaesthetic was infused. Intermittent positive pressure ventilation was set to achieve an end-tidal CO_2 of less than 40 mm Hg. Patients' vitals and Doppler parameters were measured before and at 1, 3, 5, 10, and 30 min after induction of anaesthesia. Cerebral autoregulation was again measured again at 30 min of induction of anaesthesia.

All patients were observed for the following parameters:
Clinical parameters:

1. Heart rate (HR)
2. Pulse oximetry (SpO_2)
3. Mean arterial pressure(invasive)(MAP)
4. End tidal carbon dioxide ($EtCO_2$)

TCD parameters:
1. Peak Systolic MCA flow velocity (Fvsys)
2. End Diastolic MCA flow velocity (Fvdia)
3. Mean MCA flow velocity (Fvmean)
4. Gosling's Pulsatility Index (PI) FVsys – FVdia / FVmean
5. Pourecelot's Resistivity Index (RI) FVsys – FVdia / FVsys
6. Transient hyperemic response ratio (THRR) FV3/FV1
7. Estimated cerebral perfusion pressure (eCPP)= FVmean x (BPm-BPd)/(FVm-FV)

For statistical analysis the software SPSS version 16 was used. The results were expressed as mean ± standard deviation. Students paired t tests were used to compare the means of hemodynamic and Doppler parameters between two consecutive measurements within the group. Pearson correlation coefficients were calculated to evaluate the relation between changes in MAP, $EtCO_2$, FVsys, FVdia, FVmean, PI, RI and CPP within the group. A p value of less than 0.05 was considered significant and that of less than 0.01 was highly significant.

Results: Out of the 40 patients selected for our study, 8 patients were below 30 years of age, 18 patients between 30 to 50 years age and 14 were above 50 years of age. 22 were male and 18 female. The mean weight of the patients was 56.75 ± 14.14 and the mean dose of propofol required at the time of induction was between 2.1095 ± 0.505 mg /kg. (**Table 1**).

Table 1: Demographic trends

Characteristic	Types	Number (%)
Age	< 30	08 (20)
	30 – 50	18(45)
	> 50	14 (35)
Sex	Male	22 (55)
	Female	18 (45)
Characteristic	Mean ± SD	Range
Weight	56.75 ± 14.14	25 – 85 (60)
Dose (mg/kg)	2.1095 ± 0.505	1.0 – 2.8 (1.8)

There was a decrease (9.6 ± 34%) in mean Heart rate (HR) over baseline after propofol induction which was significant (p= 0.008).The mean arterial pressure (MAP) decreased by (14.3 ± 16) % from baseline at 1 min of induction with propofol which was significant (p= 0.001) (Table 2).

Table 2: Percent change in measured parameters over baseline, after propofol induction.

Characteristic	% Change		p Value	
Time	Induction	Intubation	Induction	Intubation
HR	9.6 %	6.03%	0.008	0.07
MAP	14.3%	1.12%	0.001	0.83
CPP	26.5%	12.6%	0.026	0.070
FVsys	13.6%	14.4%	0.019	0.064
FVdia	20.9%	27.6%	0.0049	0.022
FVmean	18.1%	24.3%	0.0019	0.0029
RI	3.4%	12.4%	0.40	0.03
PI	13.3%	39%	0.13	0.014

MAP remained stable after 3 min of induction with fluctuations of less than 5 % of its preinduction values. (Figure 1).

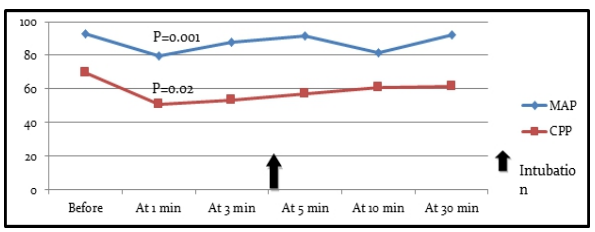

Figure 1: Effect of propofol induction on mean arterial pressure (MAP) and cerebral perfusion pressure (CPP).

The systolic flow velocities (FV sys), diastolic flow velocities (Fvdia) and mean flow velocities (FVmean) decreased significantly after induction with propofol and remained low throughout the study. (Figure 2).

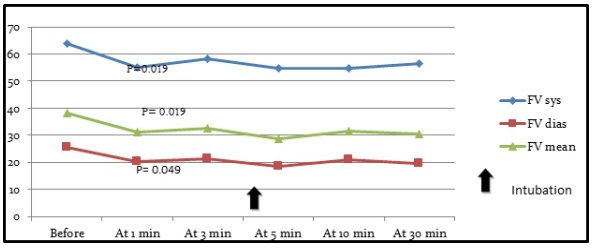

Figure 2: Effect of propofol induction on systolic, diastolic and mean flow velocities.

There was a (26.5 ± 23%; p = 0.026) fall in estimated Cerebral Perfusion Pressures (CPP) after propofol induction. (Figure 1) There was a significant increase in RI and PI at the time of intubation although the MAP did not change significantly at that time. (Figure 3).

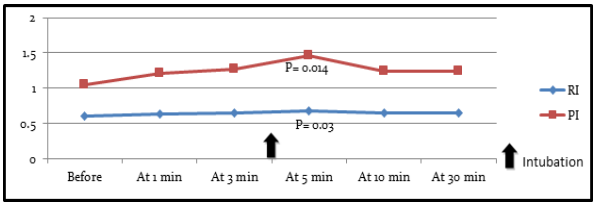

Figure 3: Effect of propofol induction on Resistivity index (RI) and Pulsatility index (PI)

We found a negative correlation of -0.45 between PI and CPP. (Figure 4).

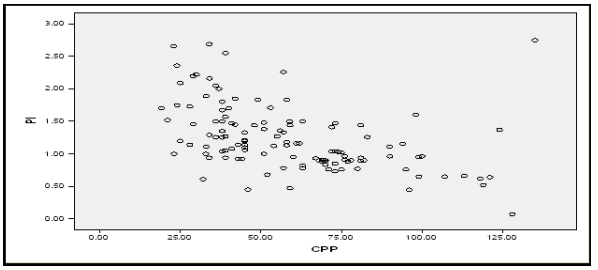

Figure 4: Correlation between Pulsatility index (PI) and cerebral perfusion pressure (CPP). Correlation coefficient =- 0.45

The Transient Hyperemic Response Ratio (THRR) did not change significantly suggestive of preserved cerebral autoregulation .The THRR was found to be 1.38 and 1.30 before and after induction with propofol respectively.

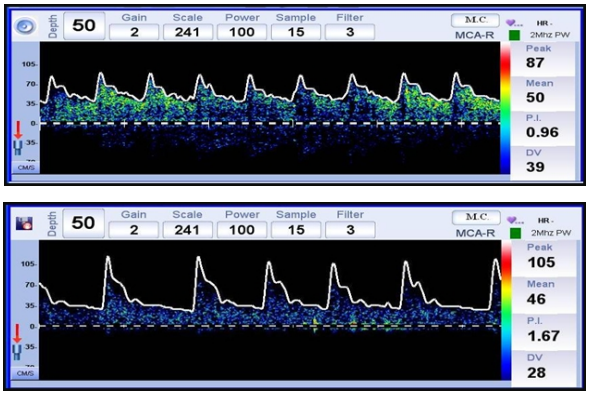

Figure 5: Giller's transient hyperemic response (THR) test.

Discussion:

TCD has become the most commonly used tool to study relative CBF changes and autoregulation in humans. Aaslid, Markwalder and Nornes in their landmark study postulated that the TCD measured velocity in the MCA, ACA, and PCA was 62 +/- 12, 51 +/- 12, and 44 +/- 11 cm/sec respectively. They also found that the MCA flow velocity is a function of the diameter of that segment of the vessel as measured by angiography. As diameter decreases, flow velocity increases. However MCA flow velocities represent CBF only when the diameter of basal cerebral blood vessels remain constant.[6] Stephan et al in their study did not find changes in the diameter of the MCA after acetazolamide provocation testing with high-resolution MR imaging thus concluding that changes in MCA flow velocity measured by TCD reflect relative changes in cerebral blood flow after acetazolamide provocation testing.[7] Sorond et al confirmed these findings in their study where they noted that changes in flow velocity in the MCA associated with drinking cocoa were highly correlated with changes in CBF measured by the two MRI techniques using the tracer gadolinium and ASL.[8] These results suggest Doppler measurements of CBF velocity are representative assessments of CBF.

The pharmacokinetic properties of propofol make the drug suitable for induction and maintenance of anaesthesia by intravenous infusion.[9] Mishra et al noted a significant decrease in both mean arterial pressure (MAP) and heart rate (HR) when midazolam and butorphanol were administered to patients 5 minutes before induction of general anaesthesia with propofol.[10] In our study, there was a similar significant fall in HR at 5 minutes of induction with propofol Harrison et al, and Matta et al *have* all observed varying degrees of fall in MCA flow velocities after propofol induction.[11,12] In our study we found a significant fall in systolic diastolic and mean MCA flow velocities after propofol induction. The systolic and mean flow velocities remained significantly below baseline throughout induction and maintenance of anaesthesia but the diastolic flow velocity increased slightly at the time of intubation but still remained 27.6% below its baseline value. Belfort et al gave the following formula for estimated CPP calculation.

$$eCPP = FVmean \times (BPm\text{-}BPd) / (FVm\text{-}FV)$$ [13]

We used this formula in our study to estimate the CPP noninvasively and found a significant fall in CPP after propofol induction. Chan et al reported a correlation (-0.725) between PI and CPP with an even better correlation (-0.942) as CPP decreased below a critical value of 70 mm Hg[14]. In our study we found a negative correlation of -0.45 between PI and CPP. Gosling et al stated that normal PI ranges from 0.6 to 1.1. PI is a useful indicator of cerebral hemodynamic assymetry.[15] The value of PI in our study increased significantly by 39% over baseline at the time of intubation even though there was no significant change in MAP at the time of intubation. Harrison and Matta have both concluded that propofol anaesthesia preserves if not improves cerebrovascular reactivity[11,12]. We used Giller's Transient Hyperemic response test to determine the auto regulatory status of our patients[16]. Our study also concurs that there is no significant change in the transient hyperemic response ratio (THRR) after induction with propofol. The THRR ratio remained above 1.0 throughout the study suggestive of intact autoregulation.

Conclusion:

Thus propofol is a suitable induction agent for patients with intracranial tumors. It maintains systemic and cerebral hemodynamics and preserves autoregulation. While MAP stabilizes within minutes of propofol induction, the significant increase in PI and RI at the time of intubation suggests that there is room for use of adjuvant drugs that may further attenuate the intubation response in patients with intracranial SOL. Transcranial Doppler Ultrasonography is a valuable addition to comprehensive neurological monitoring. It can truly be termed as the "Cerebral Stethoscope."[17]

References:

1. Howlader N, Noone AM, Krapcho M, Garshell J, Neyman N, Altekruse SF, Kosary CL, Yu M, Ruhl J, Tatalovich Z, Cho H, Mariotto A, Lewis DR, Chen HS, Feuer EJ, Cronin KA (eds). SEER Cancer Statistics Review, 1975-2010.
2. Sakabe T, Matsumoto M. Effects of anesthetic agents and other drugs on cerebral blood flow, metabolism, and intracranial pressure. Cottrell And Young's Neuroanaesthesia 5the.,ch 5: 87-103.
3. Turner B.K, Wakim J.H, Secrest J, Zachary R. Neuroprotective effects of thiopentone, propofol and etomidate. AANA Journal 2005; 73: 297- 302
4. Kosir G, Tetickovic E. Intraoperative transcranial Doppler ultrasonography monitoring of cerebral blood flow during coronary artery bypass grafting. Acta Clinica Croatica. 2011; 50(1):5-11.
5. Giller CA. A bedside test for cerebral autoregulation using transcranial Doppler ultrasound. Acta Neurochirurgica 1991; 108: 7–14.
6. Aaslid, R., Markwalder, T. M. and Nornes, H. Non-invasive transcranial Doppler ultrasound recording of flow velocity in basal cerebral arteries. Journal of Neurosurgery 1982, 57, 769–774.
7. Stephan H, Sonntag H, Schenk Hd, And Kohlhausen S. Effect of propofol on the circulation and oxygen consumption of the brain and CO2 reactivity of brain vessels in the human. Anaesthesist 1987; 36: 60–65.
8. Sorond F,Hollenberg N.K, Panych L. P, and Fisher N.D.L, Brain blood flow and velocity: Correlations between Magnetic resonance imaging and Transcranial doppler. Journal of Ultrasound Medicine 2010; 29(7): 1017–1022.
9. Shafer SL: Towards optimal intravenous dosing strategies. Semin Anesth. 1993; 12: 222–234.
10. Mishra L.D, Rajkumar N, Singh S.N, Dubey R.K, Yadav G: A Comparative Study of Propofol and Isoflurane Anaesthesia using Butorphanol in Neurosurgery. Indian Journal of Anaesthesia. 2009; 53(3): 324–9.
11. Harrison JM, Girling KJ, Mahajan RP. Effects of target-controlled infusion of propofol on the transient hyperaemic response and carbon dioxide reactivity in the middle cerebral artery. British Journal of Anaesthesia 1999; 83: 839–44.
12. Matta BF, Lam AM, Strebel S, Mayberg TS. Cerebral pressure autoregulation and carbon dioxide reactivity during propofol induced EEG suppression. British Journal of Anaesthesia 1995; 74: 159–63.
13. Belfort MA, Saade GR, Yared M, et al. Change in estimated cerebral perfusion pressure after treatment with nimodipine or magnesium sulfate in patients with preeclampsia. American Journal of Obstetrics & Gynecology 1999; 181: 402–7.
14. Chan KH, Miller JD, Dearden NM. The effect of changes in cerebral perfusion pressure upon middle cerebral artery blood flow velocity and jugular bulb venous oxygen saturation after severe brain injury. Journal of Neurosurgery 1992;77:55–61.
15. Gosling, R. G. and King, D. H. Arterial assessment by Doppler shift ultrasound. Proceedings of the Royal Society of Medicine 1987, 67, 447–449.
16. Giller CA. A bedside test for cerebral autoregulation using transcranial Doppler ultrasound. Acta Neurochirurgica 1991; 108: 7–14.
17. Syme P.D. The use of Transcranial Doppler ultrasonography as a 'cerebral stethoscope' for the assessment and treatment of acute stroke. Journal of Royal College of Physicians Edinborough 2006; 36:17–28.