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Effect of Spectral Entropy on the Requirement of Propofol During Induction of Anesthesia

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Abstract

Introduction: Entropy of electroencephalogram (EEG) quantifies the degree of chaos, complexity or irregularity of the EEG signal. The EEG activity would show more regularity in anaesthetized, than in awake patients. In recent years, Propofol is used commonly as an intravenous induction agent during General Anaesthesia as the recovery is smooth and clear.

Aims: To Study the effect of spectral entropy on the requirement of Propofol during induction of Anaesthesia.

Materials and Methods: 40 patients belonging to ASA grade 1 and ASA grade 2 undergoing spine surgeries under general anaesthesia were taken in the age group of 20 years to 60 years and randomly allocated to 2 groups after taking approval from institutional ethics committee.

Results: The demographic profile (age, age wise distribution, gender wise distribution, weight, weight wise distribution, height, height wise distribution) was comparable in both the groups. Haemodynamic parameters (heart rate, systolic, diastolic blood pressure and entropy parameters) were comparable in both the groups. The amount of propofol per kg dose decreased from 2mg/kg to 1.4mg/kg when induction was done using the entropy sensor. This decrease in the dose was statistically significant with $p<0.05$. This decrease in the total dosage was 25.3% and 27.8% with respect to the total dose and per kg dose of propofol respectively. The end result showed that inclusion of entropy monitor during general anaesthesia for induction with propofol decreased the requirement of propofol for induction when compared with propofol requirement without entropy monitoring. This decrease in propofol requirement was statistically significant. However the hemodynamic stability was not significantly different in both the groups.

Conclusion: Propofol, an intravenous induction drugwhile monitoring the depth of anaesthesia with spectral entropy, the requirement of propofol during induction of anaesthesia is significantly reduced in comparision when induction of anaesthesia was done without spectral entropy monitoring.

Keywords: Entropy of electroencephalogram; Propofol; General Anesthesia.

Introduction

Entropy of electroencephalogram (EEG) quantifies the degree of chaos, complexity or irregularity of the EEG signal. The EEG activity would show more regularity in anaesthetized, than in awake patients. Spectral Entropy is a new EEG derived parameter that may be used to model the pharmacokinetic-pharmacodynamic effects of General Anaesthestics. Datex-Ohmeda (Datex-Ohmeda division, Instrumentarium Corp., Helsinki, Finland) has developed a commercially available depth of anaesthesia monitor, the Entropy Module that is based on the time frequency balanced Spectral Entropy of the EEG.

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The two output parameters called the State Entropy (SE) & Response Entropy (RE) represent the Entropy scales. The output values can range between 0–91 for State Entropy and 0–100 for Response Entropy. State Entropy is computed over a frequency range from 0.8–32 Hz & Response Entropy is computed over a frequency range from 0.8–47 Hz. For fully awake responsive subjects, a value of 100 for Response Entropy and 91 for State Entropy is observed respectively and a difference between these parameters is usually < 10. For a clinically meaningful anaesthesia and low probability of consciousness following an administration of a General Anaesthetic (GA) in a patient, a Response Entropy value of 40–60 is considered as appropriate with Response Entropy - State Entropy difference of less than 10.[1,2]

In recent years, Propofol is used commonly as an intravenous induction agent during General Anaesthesia as the recovery is smooth and clear. High doses of Propofol can cause some side effects like hypotension, respiratory depression, vasodilatation etc., which may affect the patients who undergo surgeries under GA. Therefore, it is essential to optimize the dose of Propofol during induction. In view of the above and as Spectral Entropy monitoring is a fast and simple method of analysis of the EEG, it is proposed to study how this new device helps in decreasing the requirement of Propofolduring induction of General Anaesthesia.

Materials and Methods

40 patients belonging to ASA grade 1 and ASA grade 2 undergoing spine surgeries under general anaesthesia were taken in the age group of 20 years to 60 years and randomly allocated to 2 groups after taking approval from institutional ethics committee.

Group E (Entropy): Propofol is given in 30mg increments every 30seconds until RE values dropped to 50 and the RE-SE difference was less than 10 and confirmed clinically with loss of response to verbal commands.

Group C (Control): Propofol is given at a dose of 2mg/kg in 30 mg increments every 30 seconds and then confirmed clinically with loss of response to verbal commands.

In the operation theatre, an intravenous line to be secured after giving local anaesthesia and basic monitoring (i.e. ECG, heart rate, non-invasive blood pressure, and pulse oximetry) to be initiated. The skin of forehead is cleansed thoroughly with ether before application of entropy sensors. Entropy to be monitored with Datex-Ohmeda S/5 entropy module. In a noise free environment, baseline values of RE, SE, heart rate and blood pressure will be recorded every minute for five minutes and mean to be calculated. No patient was given premedication. All patients were allowed to breathe 100% oxygen for 3 min before induction of anaesthesia.

For the entropy group, propofol was given for induction in successive 30 mg doses every 30 sec until RE values dropped to 50 and the RE—SE difference was less than 10; this was confirmed clinically with loss of response to verbal commands. The control group was given the recommended dose of propofol at induction (2 mg/ kg) in the same manner, i.e. successive, spaced bolus of 30 mg every 30 sec to a total of 2 mg/ kg and then confirmed clinically to ensure adequate hypnosis. If the patient is still responding verbally, additional increments of 30 mg each were given. Haemodynamic variables (HR and blood pressure (BP)), RE and SE were collected at three different points, baseline value before induction of anaesthesia, after induction of anaesthesia and before intubation and 1 min after intubation.After collection of the data at the second point, fentanyl was given for all patients in a dose of 2 mcg/kg together with vecuronium 1mg/kg followed by endotracheal intubation. During intubation, if there was any increase in the reading of entropy, an additional dose of propofol 30 mg bolus was given until no increase in readings was observed, and then intubation was performed. Total dose of propofol was recorded and the dose of propofol / kg was also calculated. Anaesthesia was maintained using isoflurane and O2 air mixture. At the end of the surgical procedure, residual neuromuscular block was reversed with 0.05 mg/kg neostigmine and 10mcg/ kg glycopyrrolate.

Methodology

Sample taken at random from a population when each member of the population has an equal chance of being chosen. The purpose is to produce groups that are as nearly similar as possible prior to the experimental procedure. (SPSS 15.0 Evaluation version). Data was expressed as either mean or standard deviation or numbers and percentages. Continuous covariates were compared using analysis of variance (ANOVA). In the present study, we used student's unpaired t-test for statistical analysis. It was used because two sets of population

were compared which were independent and identically distributed with the P value reported at the 95% confidence interval. P<0.05 was considered statistically significant.

Result

Table 1: Demographic details in present study.

Details	Entropy	Control	S.E.D.	CD 95%	P-Value
N	20.000	20.000			0.058
Age					0.058
Mean	46.100	45.150	2.651	5.366	
Std. Dev.	8.341	8.425			
Shapiro Wilk	0.946	0.957			
Gender					
Male to female ratio	11/9	12/8	0.162	0.328	0.05
Shapiro Wilk	0.637	0.641			
ASA grade I and II					
ASA grade-I	15	14	0.129	0.261	0.125
ASA grade-II	5	6			
Shapiro Wilk	0.544	0.433			
Weight					
Mean	73.100	68.800	4.706	9.528	0.147
Std. Dev.	16.626	12.907			
Shapiro Wilk	0.948	0.978			

There is no significance between 2 groups in the demographic parameters.

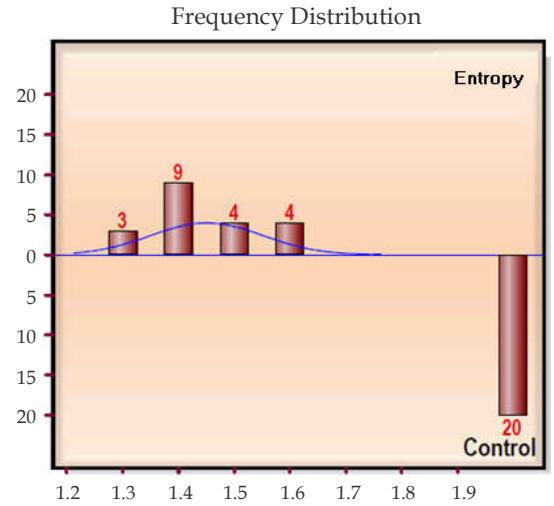

Fig. 1: Study population distribution of propofol administered per kg.

The results of the present study showed that the requirement of propofol was greatly decreased in the Entropy group.

This total dose of propofol and the dose per kg was significantly reduced by 25.3% and 27.8%, respectively, in the entropy group.

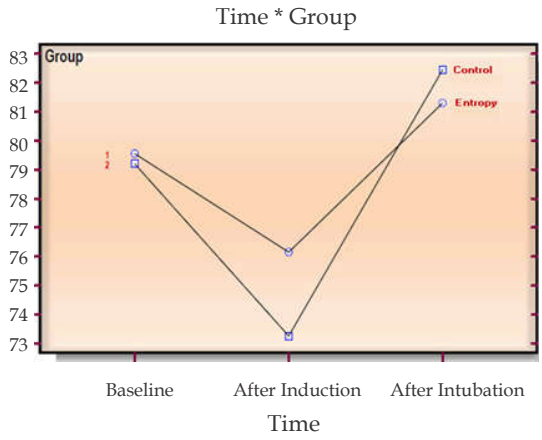

Fig. 2: Study population distribution of heart rate at different intervals.

It shows heart rate were decreased in both groups after anaesthesia induction, which was not significant when both groups were compared.

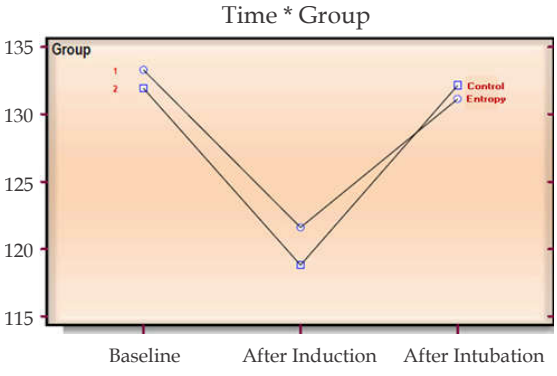

Fig. 3: Study population distribution for systolic BP at different intervals.

It shows systolic blood pressures were decreased in both groups after anaesthesia induction, which was not significant when both groups were compared.

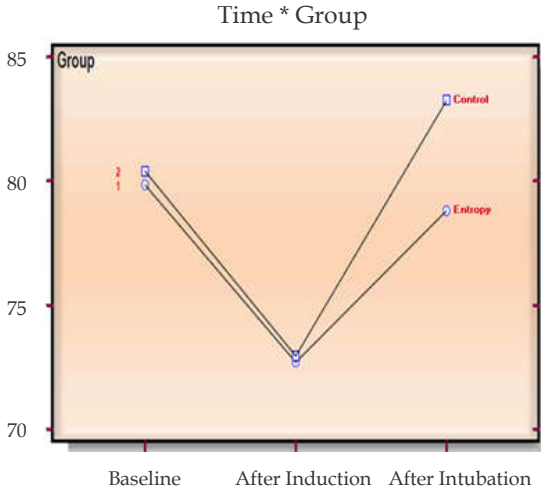

Fig. 4: Study population distribution of diastolic BP at different intervals.

It shows diastolic blood pressures were decreased in both groups after anaesthesia induction, which was not significant when both groups were compared.

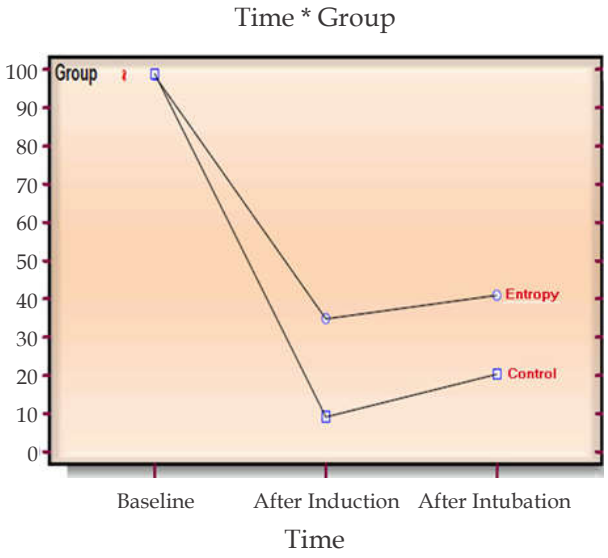

Fig. 5: Study population distribution of Response Entropy at different intervals.

There was a significant drop of entropy values in the control group as compared with the entropy group which received a greater induction dose. Adequate cardiovascular stability was observed in both groups of the patients with Entropy group showing no greater significance than the control group. Thus monitoring with Entropy decreased the consumption of Propofol in a significant proportion.

Discussion

The goal for devices measuring depth of anaesthesia is to ascertain an adequate, but not excessive, depth of anaesthesia regardless of drug or drug combination used. Such devices should allow optimal delivery of drug or drugs to each patient, to guarantee an adequate depth of anaesthesia, loss of awareness and no recall. Day surgery with propofol is an important clinical setting for monitoring the anaesthetic depth, where minimising drug use may aid rapid turnover. The present study was basically undertaken to see that by using Entropy whether we can reduce the dose of prsopofol at the time of induction. For the study, 40 patients were taken and were randomly allotted to either of the group i.e., Group E or Group C. (Table 1 and Fig. 1) The results of the present study demonstrated that the induction dose of propofol was decreased in the Entropy group in comparision with the Control group as was demonstrated in the study by W.Riadet al.[3] and Bruhn et al.[4]

The present study demonstrated heart rate were decreased in both groups after anaesthesia induction, which was not significant when both groups were as that systolic and diastolic blood pressures are decreased in both groups after anaesthesia induction with propofol (Fig. 2,3,4) which is in accordance with the study done by Hug and colleagues[5] and Michelson and colleagues.[6] Little information is available regarding the usefulness of EEG entropy in the prevention of adverse hemodynamic effects during induction of anaesthesia.Vakkuri and colleagues[7] demonstrated precise haemodynamic control at induction of anaesthesia in middle-aged patients guided by EEG entropy. Our study showed that total dose of propofol and the dose/kg were significantly reduced by 25.3% and 27.8%, respectively, in the entropy group. There was a significant drop of entropy values in the control group as compared with the entropy group which received a greater induction dose.

Sensitivity and specificity of the entropy were demonstrated in previous reports which shows that entropy is as efficient as BIS in predicting changes in the hypnotic component of anaesthesia8, and the changes in SE and RE values followed a similar pattern to the BIS values during propofol induction in adults.[9] In a comparision of different neurophysiological techniques, Muncaster and colleagues found entropy processing of the EEG to be more sensitive than BIS and auditory evoked potential.[10] Anderson and Jakobsson[11] demonstrated good correlation between propofol sedation and entropy indices in young and elderly patients.

In our study, the stress response associated with intubation led to an increase in RE and SE reading. (Fig. 5) The increase in the entropy reading was associated with increase in HR, systolic blood pressure and diastolic blood pressure in both groups. In agreement with the present work Wheeler and colleagues[12] demonstrated that RE, RE-SE difference, HR and BP were significantly increased during painful stimulation. It has been reported that excitability of subcortical structures evoked by noxious stimuli will increase the difference between RE and SE. Takamastu and colleagues[13] also reported that frontal EMG may be of value in assessing adequacy of anaesthesia and also reflects nociception, but it did not correlate with the intensity of the stimulation. This increase could be attributed to increase in nociceptive

information in the central nervous system, which activates sympathetic pathways and increases the circulating levels of catecholamines result in tachycardia and hypertension.[14] The absence of difference between the two groups, although the total dose of propofol was significantly higher in the control group, pointed to the good correlation between entropy reading and propofolplasma concentration.[15] In conclusion, the use of EEG entropy during induction of anaesthesia reduces propofol requirements.

Conclusion

Propofol, an intravenous induction drug is a common induction agent in the current anaesthesia practice. Spectral entropy, an EEG based monitor, is used to monitor adequate depth under general anaesthesia. It is also used to titrate the dosages of the drugs to achieve adequate depth thereby preventing overdosage and its associated side effects. The present study showed that while monitoring the depth of anaesthesia with spectral entropy, the requirement of propofol during induction of anaesthesia is significantly reduced in comparision when induction of anaesthesia was done without spectral entropy monitoring. Further studies with a large number of patients are required to substantiate the above result.

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