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Original Article

Anaesthesia Section

Entropy as an Indicator to Measure Depth of Anaesthesia for Laryngeal Mask Airway (LMA) Insertion during Sevoflurane and Propofol Anaesthesia

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ABSTRACT

Introduction: Assessment of the depth of anaesthesia is fundamental to the anaesthetic practice. Entropy measurement is an objective monitoring and is of two types- Response Entropy (RE) and State Entropy (SE) indicating analgesic and hypnotic levels during general anaesthesia.

Aim: The aim of our study was to assess the depth of anaesthesia for LMA placement using entropy as a tool. The assessment of entropy as an indicator of depth of anaesthesia in the form of haemodynamic variations and success rate of LMA placement.

Materials and Methods: A prospective study was carried out after ethical committee approval in 100 patients, aged 20-50 years, with ASA grade I and II of either gender undergoing elective surgery lasting less than two hours under general anaesthesia. Anaesthesia was induced with sevoflurane 2.5% and IV propofol at 6 ml/min until entropy value fell from baseline values to 30-40 and then LMA insertion was performed. SE and RE values were noted every 30 seconds for five minutes. Mean blood pressure and heart rate were recorded every minute after induction for 5 minutes.

Results: There was a significant change in RE and SE values within 30 seconds from start of induction. Desired values of RE (40.10±2.52) and SE (39.2±2.47) were achieved at 120 seconds to 150 seconds. Mean dose of propofol used during surgery was 86.5±3.5 mg and mean insertion time was 110±12 seconds Patients in study group had a stable haemodynamics throughout the procedure, (p-value -0.8).

Conclusion: Entropy is a reliable indicator to assess depth of anaesthesia for LMA placement during sevoflurane and propofol anaesthesia.

Keywords: Awareness, Bispectral index, Frontal electromyography, Jaw thrust

INTRODUCTION

With emergence of new anaesthetic techniques such as intravenous anaesthetics, potent opiate analgesics and newer volatile agents, a mean of measuring depth of anaesthesia is important. Level of anaesthesia varies with each patient and it should be individualised. Deeper anaesthesia level than required might led to anaesthesia related morbidities like postoperative nausea and vomiting, delayed recovery and cognitive dysfunctions. In converse lighter plane of anaesthesia can lead to intraoperative awareness. Signs of intraoperative awareness include tachycardia, hypertension, lacrimation, sweating etc., but all these are a rough estimation of depth of anaesthesia. Development of monitors to assess depth of anaesthesia has been the subject of much study. The appropriate measurement technique of depth of anaesthesia can be expected to reduce the incidence of awareness during general anaesthesia and also allow anaesthesia to be light enough to facilitate rapid recovery and reduce both the human and financial cost [1].

Entropy is a useful monitor for assessing the depth of anaesthesia. Entropy displays a high degree of specificity and sensitivity in assessing the consciousness during anaesthesia [2]. Entropy processes EEG and frontal electromyography data to convert these signals to numerical values, state entropy and response entropy. The RE is based on both Electroencephalogram (EEG) and Frontal Electromyography (FEMG) signals and provides an indication of the patient's responses to external stimuli and may signal early awakening. The SE is a stable parameter based on EEG and may be used to assess the hypnotic effect of anaesthetic agents on the brain. RE is always higher than or equal to the state entropy value.

Adequate depth of anaesthesia is needed for successful placement of LMA. Under lighter plane of anaesthesia inadequate mouth opening, coughing, body movements can lead to rejection of LMA [3] and may be associated with breath holding and bronchospasm.

Propofol is considered the superior inducing agent to achieve the optimum condition for LMA insertion. Inhalation induction with sevoflurane, without co-induction agent produces more excitation before insertion of LMA and takes more time to produce jaw relaxation [4]. Much less work has been done on entropy as a tool to access depth of anaesthesia.

The primary objective of our study was the assessment of entropy as an indicator of depth of anaesthesia in the form of haemodynamic variations and success rate of LMA placement.

MATERIALS AND METHODS

A prospective study was carried out after ethical committee approval in 100 patients, aged 20-50 years, with ASA grade I and II of either gender undergoing elective surgery lasting less than two hours under general anaesthesia at tertiary care centre in India during 2014 and 2015. Patients with hypertension, ischemic heart disease, cerebrovascular disease, mallampati grade III and IV, ASA grade III and IV, heart block, heart failure and body mass index ≥30 kg/m^2, previous difficult intubation, severe respiratory distress, patients on beta blockers and vasodilators and patients undergoing ENT surgery were excluded from study. Software NCSS PASS 15 was used to calculate sample size. Considering a 15% failure of entropy as a tool, to achieve power of 80% and (α) error of 0.05, 100 patients were required.

All the patients were kept nil per oral for at least 12 hours. Written informed consent was taken from the patient. In the operation theatre, routine monitors and entropy electrode on the forehead were attached using GE entropy module and sensor with

CARESCAPE monitor B650 of GE Healthcare Finland Oy. Entropy scores (both SE and RE) were displayed on the monitors along with the graph. Intravenous (IV) midazolam 2 mg, glycopyrolate 0.2 mg and nalbuphine 0.1-0.2 mg/kg were given 10 minutes prior to surgery. Preoxygenation with 100% oxygen was carried out and time of induction was noted. Patients were induced with oxygen 50%, nitrous oxide 50%, sevoflurane 2.5% and IV propofol at 6 ml/min as a continuous infusion through a infusion pump until the entropy fell from baseline values to 30-40 and then LMA insertion was performed. Induction regimen was stopped after successful placement of LMA. Bilateral chest rise with presence of capnography trace was considered the end point of completion of LMA placement. The average MAC of sevoflurane was 2.1% at the time of LMA placement. If LMA insertion was not successful in first attempt, then second attempt was made provided there should not be any coughing, swallowing or laryngospasm. Induction with sevoflurane 2.5% and propofol infusion at 6 ml/min were continued for further attempts. The procedure was declared unsuccessful after three failed attempts. Time between start of induction to insertion of LMA and total dose of propofol used were noted. Readings of state and response entropy were noted every 30 seconds during the first five minutes. Mean blood pressure and heart rate were measured every minute for five minutes.

Anaesthesia was maintained with oxygen, nitrous oxide, isoflurane and vecuronium. Patients were reversed at the end of the surgery and shifted to postoperative care unit.

STATISTICAL ANALYSIS

Data was analysed using Statistical Package for Social Sciences (SPSS) version 17.00 for windows. Categorical data like gender was presented as numbers. Age, weight, SE, RE values, heart rate and blood pressure were presented as Mean±SD. Intragroup comparison of mean blood pressure and mean heart rate was done using ANOVA. The p-value ≤0.05 was considered significant.

RESULTS

[Table/Fig-1] shows the demographic profile of 100 study group patients. Mean duration of anaesthesia was 68.25±11.81 seconds. Mean dose of propofol used during surgery was 86.5±3.5 mg and mean time taken from start of induction to LMA placement (insertion time) was 110±12 seconds [Table/Fig-1]. There was a significant change in RE and SE values within 30 seconds from start of induction. Desired values of RE and SE were achieved at 120 seconds to 150 seconds [Table/Fig-2]. Patients in study group had a stable haemodynamics throughout the procedure. There was no statistically significant difference in mean blood pressure and mean heart rate from baseline during induction and LMA placement [Table/Fig-3]. No complications like bradycardia, hypotension, apnea and bronchospasm were noted in our study.

DISCUSSION

The depth of anaesthesia has routinely been assessed by observing clinical parameters such as response to voice, pain, surgical stimulation, jaw thrust and trapezius squeeze test [5]. Various studies have proved the negative trapezious squeeze test and absence of motor response to jaw thurst as effective clinical indicators of depth of anaesthesia. The more direct and reliable method of measuring anaesthetic drug effect on the brain is highly desirable and has been the object of research for many years.

The recent development is seen in assessing the depth of anaesthesia using EEG. EEG is a brain monitoring modality which is non invasive and continuous. Technologies and monitors have been developed to interpret and analyse these signals to provide a numerical value. Entropy monitoring provides quantitative measurement of depth of anaesthesia. The RE scale ranges from 0 (no brain activity) to 100 (fully awake) and the SE scale ranges from 0 (no brain activity) to 91

Characteristic	N	Value
Age (years)	100	39.9± 9.92
Gender (M/F)	100	55/45
Weight (Kg)	100	62.2±12.1
Duration of anaesthesia (seconds)	100	68.25±11.81
Total propofol used (mg)	100	86.5± 3.5
Insertion time (s)	100	110±12

[Table/Fig-1]: Patient Characteristics.

Time	RE	SE
0 s	97.00±0.04	94.00±0.14
30 s	83.60±1.96	82.44±2.77
1 min	66.40±1.64	62.60±1.34
1.5 min	50.30±1.22	49.20±1.68
2 min	41.55±2.89	40.40±2.71
2.5 min	40.10±2.52	39.2±2.47
3 min	38.71±2.54	37.71±2.44
3.5 min	37.44±2.04	36.53±1.93
4 min	36.24±1.94	35.43±1.97
4.5 min	36.44±1.98	36.40±1.90
5 min	38.84±2.54	38.8±2.56

[Table/Fig-2]: SE and RE at various time intervals during and after induction.
SE - State Entropy, RE - Response Entropy

Variables	N	Mean Blood Pressure	p-value	Mean Heart Rate	p-value
Baseline	100	87.56 ± 7.05	---	84.56 ± 10.42	----
1 min	100	85.38± 11.55	0.10	82.76 ± 7.97	0.17
2 min	100	87.22± 10.96	0.80	83.91 ±7.66	0.62
3 min	100	87.68 ±11.23	0.93	85.33± 9.07	0.58
4 min	100	85.88± 9.73	0.16	85.16± 8.08	0.65
5 min	100	86.61± 10.17	0.44	83.29± 8.21	0.38

[Table/Fig-3]: Analysis of haemodynamic parameters.

(fully awake). The clinically relevant target range for entropy values is 40-60. RE and SE values near 40 indicate a low probability of consciousness [6]. A study done by Balci C et al., using propofol and fentanyl sedation in monitored anaesthesia care concluded entropy monitoring is as sensitive as Bispectral Index (BIS) [7]. Similarly, Patel CR et al., evaluated the depth of anaesthesia by entropy analysis to study the effect of dexmedetomidine infusion on sevoflurane requirement during general anaesthesia [2]. In our study, we noticed a constant decrease in entropy values from baseline during sevoflurane and propofol induction for LMA placement. Bharadwaj S et al., in their study monitored entropy in patients with parkinsonism and movement disorders and found it as effective as BIS during all planes of anaesthesia and various stages of surgery [8]. There were no significant changes in mean blood pressure and mean heart rate from baseline during LMA placement which indicates adequate depth of anaesthesia.

Mean propofol requirement in our study was 86.5±3.5 mg. Higher dose of propofol might be required to achieve adequate depth of anaesthesia which is associated with frequent apnoea episodes [9]. Similarly, inadequate jaw relaxation and increased muscle tone are the main concerning factors with inhaled anaesthetics alone for adequate LMA placement [10]. So, in our study we used sevoflurane 2.5% and propofol at 6 ml/min as induction agents for LMA placement. A 94% patient had successful placement of LMA in the first attempt. Success rate of LMA placement was 100% in our study.

Similar study done by Siddik-Sayyid SM et al., concluded sevoflurane-propofol to be a better induction agent than sevoflurane and propofol alone for most frequent successful LMA placement without adverse effects [11]. Mean time from induction to successful LMA placement with cuff inflation was 110±12 seconds which was comparable to the study of Siddik-Sayyid SM et al., (108±18 seconds) [11]. In contrast study of Priya V et al., less time was taken for LMA placement which could be due to higher dose of propofol and sevoflurane used [12]. There were no complications (apnea, bronchospasm, bradycardia, hypotension) in our study.

LIMITATION

Limitation of our study was non-availability of BIS which could have been used to compare with entropy and can be done in future.

CONCLUSION

Entropy is a reliable indicator to assess depth of anaesthesia for LMA placement during sevoflurane and propofol anaesthesia.

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