

Association between bispectrality index (bis) values and post operative shivering in patients undergoing elective laparoscopic hernia surgery.

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Abstract

Background: Post-operative shivering (PS) is a common and distressing complication after anaesthesia and surgery.

Aim: To study the association between Bispectrality Index (BIS) values and Postoperative Shivering in patients undergoing laparoscopic hernia surgery.

Material and methods: This cross-sectional observational study was conducted in Dr RML hospital in New Delhi, India from November 2019 to March 2021. Patients who underwent elective laparoscopic hernia surgery under general anesthesia were included in the study. BIS values, HR, SBP and DBP monitoring was done at an interval of 10 mins during perioperative period and the presence of post operative shivering was evaluated using a scale proposed by Crossley and Mahajan.

Results: A total number of 95 patients were evaluated in this study. The minimum and maximum bis score distribution in those patients having shivering score of 0 was 42-50, shivering score of 2 was 42-52 and shivering score of 3 was 42-54. The binary logistic regression

model indicated a statistically significant relationships between post operative shivering score and hr, sbp, dbp and bis values ($p < 0.05$).

Conclusion: Our study concludes that there is a significant positive association between bis values and post operative shivering in patients undergoing elective laparoscopic hernia surgery. Also, higher bis values were present in patients who had higher grades of shivering. It seems that bis guided anesthesia can alter incidence of post operative shivering in patients undergoing laparoscopic hernia surgery under general anesthesia.

Keywords: General Anesthesia, Bispectral Index(Bis), Post Operative Shivering, Laparoscopic Hernia Surgery, Depth of Anesthesia.

Introduction

Post-operative shivering (PS) is a common and distressing complication after anaesthesia and surgery¹. Shivering can cause stretching at the incision site and increase post-operative surgical site pain. Shivering causes production of heat and increases oxygen consumption by 300-400% which increases risk of hypoxemia and further leads to critical ischemia, lactic

acidosis, increased production of carbon dioxide and release of catecholamines, which results in increased heart rate, cardiac output and blood pressure². Post-operative shivering increases the chances of infection, pain, bleeding, delay in wound healing and all these complications leads to increase in duration of both post anaesthesia care unit (PACU) and hospital stay².

Pathophysiology of Post-operative shivering-Post anaesthetic shivering electromyographic (EMG) pattern recording helps us to identify three types of EMG signals which are-

- a. Tonic EMG activity.
- b. spontaneous EMG **clonus** which is similar to pathological clonus present in patients with spinal cord transection.
- c. waxing and waning signals.

The clonic pattern is not a normal component of thermoregulatory shivering and it is associated with recovery from volatile anaesthetic agent². It is due to the loss of inhibition of spinal reflexes by general anaesthetic². Shivering occurs when the preoptic region of hypothalamus is cooled and then the efferent fibres mediating shivering signals descends in the medial forebrain bundle.² Spinal alpha motor neurons and their axons are the final common path for both coordinated movement and shivering². Several factors play a role in post-operative shivering which includes intraoperative hypothermia, respiratory alkalosis, pain in post-operative period, use of certain anaesthetics like halogenated agents, early recovery of spinal reflexes, presence of pyrogen in body, over activity of sympathetic system³. Recent studies have suggested that the depth of anaesthesia has significant association for development of post-operative shivering¹.

There are various methods for managing post-operative shivering- pharmacological and non-pharmacological

methods. Non-pharmacological measures include pre-operative skin surface rewarming which efficiently limits the effects of internal redistribution. Forced air warmer to be used 30 minutes prior to induction of anaesthesia prevents internal heat redistribution³. Raising the operating room temperature (>28°C) prevents heat loss via radiation and Intravenous (IV) fluid warmers are also used when large volumes of crystalloid or colloid or cold blood products are to be transferred; IV solution rewarming prevents the patient from cooling down³.

Pharmacological measures for preventing shivering include drugs such as Tramadol, Dexamethasone, Pethidine, Clonidine, Physostigmine. Pethidine is the most prevalent drug for managing post-operative shivering¹. Amino acid infusion in perioperative period will increase the body temperature of the patient which will lead to decrease in frequency of postoperative shivering⁴. Dexmedetomidine, alpha-2 adrenergic agonist is also helpful in decreasing post-operative shivering⁵.

Parecoxib, a selective cyclooxygenase 2 (COX-2) inhibitor has dual role by effectively controlling both post-operative shivering and post-operative analgesia⁶. Hydrocortisone and ketamine (NMDA receptor antagonist) are effective in controlling postoperative shivering². *Hoda et al in 2010*⁷ concluded that prophylactic use of tramadol in a dose of 1mg/kg at the time of skin closure when induction agent used was propofol, significantly reduce the incidence of postoperative shivering⁷.

The Bispectral index (BIS) is an empirically derived scale that was first proposed in 1994 by Aspect Medical Systems and later by Medtronic as a method of monitoring depth of anaesthesia⁸. BIS uses information from 3 EEG analyses – the spectrogram, the bispectrum and a time domain assessment of burst suppression. After that the EEG also undergoes artefact corrections. There is

a 20-30 second lag between the time the EEG is observed and the computation of the corresponding BIS value⁸. The EEG is recorded by a 4-lead frontal montage. The sensors are placed over patients' forehead and electrical signals are picked up from the cerebral cortex and then transferred to digital signal connector⁹.

Materials and methods

In a cross-sectional observational study, 95 adult patients of ASA grade I & II, age group between 16-65 years of either sex, undergoing elective laparoscopic hernia surgery under general anaesthesia were included. Study was done from November 2019 to March 2021, in the department of anesthesiology of A.B.V.I.M.S & Dr. Ram Manohar Lohia Hospital, New Delhi. Approval from the Institutional Ethical Committee and registering with a CTRI number of CTRI/2020/04/024491 and informed consents from the patients, were obtained.

Exclusion criteria

Peri-operative bleeding greater than one litre, need for blood transfusion, presence of any infections, duration of surgery more than 180 minutes, administration of any drugs in preoperative and/or intraoperative period which might alter the result such as Tramadol, Meperidine, Hydrocortisone, known hypersensitivity to anesthetic agents from previous history, patients who are on antiemetics or steroids preoperatively, patients with well-known history of psychiatric illness.

The preanesthetic regimen, anaesthesia procedure and surgical technique were standardized and uniform for all the patients enrolled in this study. All patients received Inj. Midazolam 0.01-0.02 mg/kg of body weight. Then Inj. Fentanyl 2 microgram/kg and Inj. Thiopental Sodium 5 mg/kg followed by Inj. Vecuronium 0.1 mg/kg to facilitate orotracheal intubation. Anaesthesia was maintained with 50 percent Oxygen, 50 percent Nitrous oxide and inhalational agent Sevoflurane was titrated to

achieve a value of BIS between 40-60 and top up doses of Vecuronium after every 30 minutes and Fentanyl after every 45 minutes were given. Intraoperative Pain relief prophylaxis: Intraoperative pain relief was achieved with Inj. paracetamol infusion 15 mg/kg and Inj. diclofenac sodium aqueous 1mg/kg slow intravenously 20 minutes before completion. Intraoperative Antiemesis Prophylaxis: At the end of the surgery Inj. ondansetron 0.1 mg/kg was administered to all patients. Intraoperative Thermoregulation: Normothermia was maintained throughout the perioperative period using warmed intravenous fluids and forced air warming device. Reversal of neuromuscular blockade: Inj. neostigmine 0.05 mg/kg and Inj. glycopyrrolate 0.01 mg/kg.

Intraoperative monitoring

Patients Heart rate, SpO₂, ECG, NIBP, Temperature was monitored throughout the intraoperative period at an interval of 10 minutes. BIS monitoring for recording of the depth of anaesthesia was started exactly 5 minutes after intubation. BIS monitoring was done throughout the intraoperative period at an interval of 10 minutes.

Postoperative monitoring

Patients was monitored in the Post Anaesthesia Care Unit (PACU) for hemodynamic parameters- Heart rate, Blood Pressure, SpO₂ and patients was assessed for the presence of any shivering by "The Shivering Classification"¹⁰ proposed by A.W.A. Crossley and R.P. Mahajan. All the parameters were recorded at time points from 1-5, with 1- corresponding to immediate post-operative period and then values were recorded at an interval time of 15 minutes each till discharge from Post operative Care Unit.

The shivering classification

| Grade | Description |
|-------|--|
| 0 | No shivering |
| 1 | No visible muscle activity, but one or more of piloerection, peripheral vasoconstriction or peripheral cyanosis (other causes excluded). |
| 2 | Muscular activity in only one muscle group. |
| 3 | Moderate muscular activity in more than one muscle group, but not generalized shaking. |
| 4 | Violent muscular activity that involves the entire body. |

Postoperative shivering management

Patients if showing signs & symptoms of shivering according to “The Shivering Classification” were given a rescue treatment with Inj. tramadol 1mg/kg by slow intravenous route.

Statistical analysis

The frequency and percentage is used to describe discrete data. The median and the interquartile range (IQR) is used to describe continuous data as the data were non-normally distributed. The normality of data has been checked by using Shapiro-Wilk test. The chi-square/Fisher’s Exact test has been used to find the association between categorical variables. The Wilcoxon rank sum test (Mann-Whitney U test) has been used to compare the two independent groups with respect to some continuous variable. The Friedman test is used to find the difference within group at different time point. A significant Friedman test can be followed up by pair wise Wilcoxon signed-rank tests for identifying which groups are different. P-values are adjusted using the Bonferroni multiple testing correction method. A binomial logistic regression (often referred to simply as logistic regression has been used, predicts the probability

that an observation falls into one of two categories of a dichotomous dependent variable based on one or more independent variables that can be either continuous or categorical. The p-value is considered as significant if it is less than level of significance (<0.05).

Results

Out of 95 subjects, there are 63 males (66%) and 32 females (34%). Only, 32% (n=30) subjects needed rescue therapy. Age is non-normally distributed with median and IQR as 38(26.5).

| Parameters (n=95) | | n (%) |
|-------------------------|-----|---------|
| Sex | M | 63(66%) |
| | F | 32(34%) |
| Need for Rescue Therapy | NO | 65(68%) |
| | YES | 30(32%) |
| Shivering Score | 0 | 65(68%) |
| | 1 | 0(0%) |
| | 2 | 18(19%) |
| | 3 | 12(13%) |
| | 4 | 0 (0%) |

Table 1: Demographic characteristics.

Shivering grade distribution

| Sex | SHIVERING GRADE | | | Total | P-value |
|--------|-----------------|----------|----------|----------|---------|
| | 0 | 2 | 3 | | |
| Female | 21(32%) | 8(44%) | 3(25%) | 32(34%) | 0.535 |
| Male | 44(68%) | 10(56%) | 9(75%) | 63(66%) | |
| Total | 65(100%) | 18(100%) | 12(100%) | 95(100%) | |

Table 2: Fisher’s Exact Test.

It is clear from the above table that there is no association between sex and shivering grade as p-value is insignificant (>0.05).

| Parameters | Median (IQR) | | p-value |
|-------------|--------------|-----------|---------|
| | Group 1 | Group 2 | |
| HR | 76(6) | 86(6) | <0.001 |
| SBP | 124(6) | 128(6) | <0.001 |
| DBP | 76(14) | 82(10) | <0.001 |
| BIS | 45(2) | 48(3) | <0.001 |
| Temperature | 36.5(0.6) | 36.5(0.6) | 0.794 |

Table 3: Wilcoxon Rank Sum Test (Group1= Non-shivering; Group2= Shivering)

It is clear from the above table that there is a difference between the groups (shivering vs. non-shivering) with respect to the parameters Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, Bispectral Index Score during intra-operative period as the p-value is less than level of significance (<0.05).

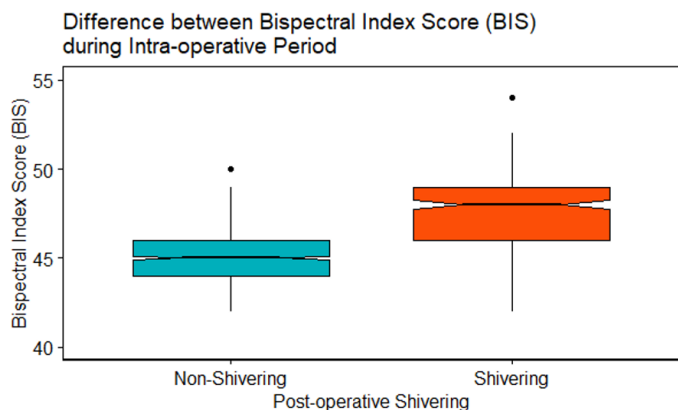


Figure 1: The above boxplot is showing the distribution of BIS during intra-operative period between the groups having shivering and no shivering. It is observed from the above boxplot that the data is skewed and median is higher in the shivering group than no shivering group which can also be supported by numerical measures. There are some outliers in both the groups. The graph also reveals that the BIS distribution of the shivering group is higher than no shivering group.

| Parameters | Univariate | | Multiple | |
|-------------|-----------------|---------|-----------------|---------|
| | OR (95% C.I.) | p-value | OR (95% C.I.) | p-value |
| HR | 1.21(1.18-1.24) | <0.001 | 1.16(1.14-1.2) | <0.001 |
| SBP | 1.15(1.12-1.18) | <0.001 | 1.15(1.13-1.2) | <0.001 |
| DBP | 1.07(1.05-1.09) | <0.001 | 1.06(1.04-1.08) | <0.001 |
| BIS | 1.43(1.35-1.52) | <0.001 | 1.39(1.3-1.51) | <0.001 |
| Temperature | 0.96(0.72-1.29) | 0.785 | 1.03(0.7-1.52) | 0.864 |

Table 4: Binary Logistic Regression (unadjusted for Age and Sex)

From the above table, the univariate binary logistic regression model indicated a statistically significant relationship between shivering score and heart rate ($p < 0.001$), Systolic Blood Pressure ($p < 0.01$), Diastolic Blood Pressure ($p < 0.01$) and BIS score ($p < 0.001$). Similarly, multiple binary logistic regression model showed a significant p-value for heart rate, systolic blood pressure, diastolic blood pressure and BIS score. The odds ratio from the univariate regression model are indicating that the odds of shivering are 21%, 15%, 7% and 43% higher than the odds of no shivering due to heart rate, SBP, DBP and BIS score respectively. Similarly, the odds ratio from the multiple regression model are indicating that the odds of shivering are 16%, 15%, 6% and 39% higher than the odds of no shivering due to heart rate, SBP, DBP and BIS score respectively. From the above results, it is clear that the shivering is more likely to occur as the heart rate, SBP, DBP and BIS increases because odd ratios are greater than 1 and p-values are also statistically significant whereas the temperature has odd ratio less than 1 (from the univariate regression analysis) and the p-value is statistically insignificant which means shivering is less likely to occur as the temperature increases from the observed data.

| Shivering Score | Bispectral Score (Minimum - Maximum) |
|-----------------|--------------------------------------|
| 0 | (42 - 50) |
| 1 | - |
| 2 | (42 - 52) |
| 3 | (42 - 54) |
| 4 | - |

Table 5: The above table shows the minimum and maximum values of BIS scores and the corresponding shivering grades.

Discussion

In our study, we have observed a significant association between BIS values and shivering as p value is less than level of significance (<0.05) [Table 3]. Higher grades of shivering were observed in patients in patients who had higher BIS values [Table 5]. The binary logistic regression model indicated a statistically significant relationships between post operative shivering score and HR, SBP, DBP and BIS values [Table4]. Several studies have mentioned intraoperative hypothermia as one of the major causes of post operative shivering³. In this study normothermia was maintained during the perioperative period between 36-37° C. Duration of surgery of all included patient in this study was of 2 hours only as prolonged surgery is a predisposing factor for post operative shivering. *Habibi et al* showed Pentothal in patients who underwent anesthesia showed a greater incidence of postoperative shivering compared to propofol¹¹. Halogenated agents have shown to display more post-operative shivering after general anesthesia. A study by Lewis et al. has shown that dexmedetomidine and clonidine have shown to decrease the incidence of post-operative shivering¹². We used the same drug protocol for administration of general anesthesia in all our patients. We did not use propofol in our study to avoid any bias as it is shown to reduce post-operative shivering. In our study, thiopental sodium was used for induction and use of opiates and benzodiazepines in patients were in accordance to their BIS level.

Conclusion

There was no statistically significant association between post-operative shivering and sex, age and need for rescue therapy. There was no association between sex and shivering grade. There was no difference between the shivering and non-shivering groups with respect to

temperature, as we maintained normothermia in all patients.

The heart rate distribution of the shivering group is higher than the non-shivering group. The systolic blood pressure distribution of the shivering group is higher than the non-shivering group. Higher diastolic pressure distribution was seen in the intra-operative period but in the post-operative period, DBP distribution of the shivering group had less variation than the non-shivering group. We also noted that the minimum and maximum BIS score distribution in those patients having shivering score of 0 was 42-50, shivering score of 2 was 42-52 and shivering score of 3 was 42-54. Our study concludes that there is a significant positive association between BIS values and post operative shivering in patients undergoing elective laparoscopic hernia surgery. Also, higher BIS values were present in patients who had higher grades of shivering. It seems that BIS guided anesthesia can alter incidence of post operative shivering in patients undergoing laparoscopic hernia surgery under general anesthesia.

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