

Association Between Bispectral Index (BIS) Value and Postoperative Shivering in Patients Undergoing Orthopedic Surgery

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Abstract

BACKGROUND: Postoperative shivering is one of the most common adverse effects after general anaesthesia.

AIM: This study aimed to evaluate the association between the Bispectral index (BIS) monitoring value and postoperative shivering in patients undergoing orthopaedic surgery.

MATERIAL AND METHODS: This cross-sectional study was conducted in Shahid Beheshti Hospital in Sabzevar city, from August 2017 to September 2018. Patients who underwent orthopaedic surgery, using general anaesthesia, were enrolled. Recording of the depth of anaesthesia using BIS monitoring was started exactly 5 minutes after intubating the patient and continued until the discharge from post-anaesthesia care unit (PACU). The incidence of postoperative shivering was evaluated using a scale proposed by Crossley and Mahajan.

RESULTS: A total number of 80 patients were evaluated. 32.5% of patients experience postoperative shivering grade 2, with mean BIS score 41.85. The univariate and multivariate linear regression analysis indicated a statistically significant relationship between shivering score and patients' heart rate, blood pressure, BIS score, temperature, age, height, gender and blood cell distribution width (RDW) ($p < 0.05$).

CONCLUSION: The results of this study indicate a significant positive association between BIS value and postoperative shivering in patients undergoing orthopaedic surgery, so that, patients with higher BIS score experienced significantly more postoperative shivering. It seems that BIS-guided anaesthesia can reduce the risk and incidence of postoperative shivering in patients undergoing orthopaedic surgery.

Citation: Yousefi Moghadam M, Nemat-Shahi M, Dowlat-Abadi B, Safari SE, Yajan S. Association Between Bispectral Index (BIS) Value and Postoperative Shivering in Patients Undergoing Orthopedic Surgery. Open Access Maced J Med Sci. 2019 Apr 15; 7(7):1166-1169. <https://doi.org/10.3889/oamjms.2019.240>

Keywords: Anesthesia; Consciousness Monitors; Bispectral index (BIS); Shivering; Orthopedics

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Received: 14-Feb-2019; **Revised:** 21-Mar-2019; **Accepted:** 22-Mar-2019; **Online first:** 14-Apr-2019

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Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Introduction

Postoperative shivering is one of the most common adverse effects after general anaesthesia, with an incidence ranging from 20 to 70% [1], [2], [3]. Postoperative shivering which has been defined as an involuntary movement of the muscles can lead to an increase in patients' metabolism two times more than the normal and cannot be controlled by them. Also, it can cause discomfort and dissatisfaction for patients after surgery. Postoperative shivering has different adverse effects such as 400 times increase in oxygen consumption, increase in plasma catecholamine concentrations, carbon dioxide production, increase in blood pressure and heart rate, increase in intracranial

and intraocular pressure [3], [4]. Additionally, it can aggravate postoperative pain, which can consequently prolong the recovery from anaesthesia and delay discharge after surgery [5]. There are different approaches for managing post-operative shivering. Postoperative skin surface is rewarming, keep the room warm and administration of oxygen are among the non-pharmacologic interventions for prevention of shivering after surgery.

Nonetheless, they are less efficient than certain drugs such as tramadol, dexamethasone, pethidine, clonidine and physostigmine [6], [7], [8]. Pethidine is the most prevalent drug for managing postoperative shivering [9]. This drug may cause respiratory depression. Using pethidine may cause a

delay in patients' discharge from post-anaesthesia care unit (PACU), increase the incidence of postoperative nausea and vomiting, decrease the peristaltic movement of the gastrointestinal system and delay in normal enteral nutrition in the postsurgical period [10]. The exact mechanism of postoperative shivering is not well elucidated [11]. Although perioperative hypothermia has been considered as one of the possible mechanisms of postoperative shivering [7], [11], this has not been confirmed by more recent studies [12]. Recently, the depth of anaesthesia has been suggested as a probable risk factor for developing postoperative shivering [3], [13], [14]. One method in monitoring the depth of anaesthesia is using electroencephalogram [bispectral index system (BIS)] [15]. BIS score is clinically used to monitor patients' responsiveness and anaesthesia depth during general anaesthesia. BIS scores ranging from 0 to 100 that has a vice versa relationship with the depth of anaesthesia [16]. For instance, once a BIS score is more than 60, the anaesthesia is light, and once it is less than 40, it is too deep. Anaesthesiologists can use BIS monitoring for better managing of anaesthetised patients and prevent the associated complications [16], [17].

Considering the probable effect of depth of anaesthesia in the occurrence of shivering after surgery and also the adverse effects of current remedies for managing this complication, as well as the relatively high prevalence of postoperative shivering in patients undergoing orthopaedic surgeries [18].

This study aimed to investigate the relationship between BIS value and postoperative shivering in patients undergoing orthopaedic surgery.

Material and Methods

In a cross-sectional study, all patients with age between 16-60 years, who were a candidate for any orthopaedic surgeries under general anaesthesia were included in this study. The study was done from August 2017 to September 2018, in an orthopaedic unit of a teaching hospital affiliated with Sabzevar University of Medical Sciences, Sabzevar, Iran. Exclusion criteria were postoperative bleeding greater than one litre, needing to blood transfusion, surgery lasting more than three hours, premedication administration, corticosteroid's administration during surgery, administration of any drug which might change the result (such as pethidine, ondansetron, hydrocortisone) and opium addiction. Approval from the Sabzevar University of Medical Sciences ethics committee, as well as informed consents from patients, was obtained. Patients' demographic characteristics were recorded. Also, venous blood samples for complete blood count (CBC) test was

taken from all patients, preoperatively.

For anaesthesia, all patients received midazolam with a dosage of 0.01 to 0.02 mg/kg of body weight. Then 2 microgram/kg of fentanyl, thiopental sodium 5 mg/kg and 0.5 mg/kg Atracurium was bloused. For maintenance of anaesthesia, 50 per cent nitrous oxide and 50 per cent oxygen at a flow of 3-6 litre/minute were used as an adjunct to the main drugs. Isoflurane was administered at MAC of 1.15. Atracurium with a 0.2 mg/kg of body weight every 30 minutes was administered. Fentanyl with one mg/kg dosage every 45 minutes were also given. The muscle relaxant was reversed with a combination of neostigmine and atropine (with a dosage of 0.04 and 0.02 mg/kg in order). The standard monitoring, including pulse oximetry, noninvasive blood pressure cuff and electrocardiogram leads were attached to the patients. BIS monitoring sensors (BIS Vista, Aspect Medical System, USA) were also attached to the patients for monitoring anaesthesia depth. BIS score classified from 0 to 100 indicating unconscious to fully awake. A typical BIS score in patients who are awake is 90 to 100. Lower values indicate a higher hypnotic effect [16], [17]. Recording of the depth of anaesthesia was started exactly 5 minutes after intubating the patient and was continued on the recovery stage of anaesthesia (stopping the maintenance drugs). Patients' vital signs, as well as BIS values, were recorded every 5 minutes before and after transfer to the post-anaesthesia care unit (PACU). In the PACU and until PACU discharge, patients' shivering was graded using the scale described by Crossley and Mahajan which is 0 = no shivering, 1 = cyanosis and piloerection, 2 = visible tremors only in one muscle group, 3 = visible tremors in more than one group of muscles, and 4 = intense shivering, tremors of the head, arm, by an anaesthesia nurse who was blinded to the study groups [19].

The data were analysed using Statistical Analysis Software (SAS; edition 9.2). The demographic and clinical data were tabulated into two groups; shivered and not-shivered for normally distributed data, independent T-test and for non-normal distributed data the Mann-Whitney test was used. For determination of the association between anaesthesia depth and shivering incidence a logistic regression model was used. A p-value of 0.05 and less was considered as significant.

Results

In total 80 patients completed the study; of them 14 (17.5%) were female, and 66 (82.5%) were male. The mean age was 34.07 years, with a minimum of 16 and a maximum of 65 years. The average weighs for the patients was 72.52 (50-120) kg. Average haemoglobin level was 15.69 g/dL. Other

demographic and preoperative laboratory profiles are listed in Table 1.

Table 1: Patients' demographic and preoperative laboratory profile

Variables	Mean	Standard Deviation	Minimum	Maximum
Age	34.07	15.44	16.00	65.00
Weight	72.52	13.22	50.00	120.00
Height	173.83	7.11	148.00	190.00
Hematocrit	36.18	6.78	14.70	47.00
RDW	14.13	0.82	12.70	16.60
MCV	83.74	4.97	76.00	97.00
MCH	96.18	439.88	25.20	28.79
Hemoglobin	15.69	20.56	7.00	14.50
MCHC	195.71	724.11	30.00	33.75

RDW: Red cell Distribution Width; MCV: Mean Corpuscular Volume; MCH: Mean Corpuscular Hemoglobin; MCHC: Mean Corpuscular Hemoglobin Concentration

The mean values of patients' vital signs in PACU and BIS scores during surgery are presented in Table 2.

Table 2: Mean values of patients' vital signs and BIS scores in PACU

Variables	Mean	Standard Deviation	Minimum	Maximum
Heart Rate	84.23	16.18	58.80	128.00
Blood Pressure	120.09	13.78	95.01	155.51
BIS	41.85	12.06	20.40	70.73
Temperature (°F)	97.30	1.01	91.87	99.64

Regarding the shivering incidence and severity, most of our patients did not experience shivering (42.50%); however, a large majority of them had the last stage (grade 4) of shivering (32.50%); the data for Crossley's classification are shown in Table 3.

Table 3: Shivering Stages of the patients

Shivering grade	Frequency	Percentage
0	34	42.50
1	5	6.25
2	1	1.25
3	14	17.50
4	26	32.50

The mean value of the BIS score was 41.85. The univariate linear regression model indicated a statistically significant relationship between Crossley shivering score and heart rate ($p = 0.0009$), BIS score ($p < 0.0001$), temperature ($p = 0.01$), age ($p < 0.0001$), height ($p = 0.012$), and female gender ($p = 0.0018$). Multiple linear regression models, adjusted for age and gender, showed a significant p -value for blood pressure, BIS score, temperature, red blood cell distribution width (RDW), and age (Table 4).

Table 4: Univariate and multivariate linear regression model, adjusted for age and gender

Parameter	Univariate		Multiple	
	Beta Coefficient (95% CI)	P value	Beta Coefficient (95% CI)	P value
Heart Rate	0.04 (0.02, 0.06)	0.0009	0.01 (-0.02, 0.04)	0.4172
BP	-0.00 (-0.04, 0.02)	0.7063	-0.02 (-0.05, 0.00)	0.0472
BIS	-0.90 (-0.11, -0.63)	<0.0001	-0.08 (-0.10, -0.06)	<0.0001
T	-0.05 (-0.88, -0.11)	0.0122	-0.54 (-0.88, -0.20)	0.0021
Weight	-0.01 (-0.05, 0.02)	0.3078	-0.03 (-0.06, 0.00)	0.0906
Height	0.10 (0.04, 0.14)	0.0012	0.00 (-0.07, 0.07)	0.9794
HTC	-0.01 (-0.09, 0.07)	0.6873	-0.01 (-0.09, 0.06)	0.7482
RDW	-0.30 (-1.02, 0.30)	0.3196	-0.40 (-1.03, 0.30)	0.0240
MCV	-0.07 (-0.18, 0.04)	0.2144	-0.04 (-0.15, 0.07)	0.4240
MCH	0.00 (-0.0004, 0.002)	0.1849	0.00 (-0.0005, 0.002)	0.2801
HB	-0.01 (-0.04, 0.02)	0.4068	-0.02 (-0.04, 0.01)	0.1963
MCHC	-0.00 (-0.001, 0.0002)	0.1856	-0.00 (-0.001, 0.0002)	0.1625
Gender	-1.62 (-2.63, -2.62)	0.0018	-0.88 (-1.92, 0.17)	0.0986
Age	-0.06 (-0.09, -0.04)	<0.0001	-0.06 (-0.08, -0.03)	<0.0001

Discussion

Our data indicated a positive relationship between BIS score and occurrence of postoperative shivering; this suggests that an awake state (higher BIS value during anaesthesia) would result in a higher stage of postoperative shivering. Recent studies on BIS and its benefits stated many advantages for BIS-guided anaesthesia [16]; however, there was a controversy for the clinicians about the effect of BIS on their decision for drug utilisation, many declared no change for their choice-of-drug [20]. Our study may introduce a new insight into BIS; that is the effect of anaesthesia depth on postoperative shivering. We have found that a BIS value around 40, which is the maximum allowable patients' anaesthesia stage, would be beneficial for reducing the incidence of shivering in the recovery period. In the literature, researchers suggested different cause for shivering; mainly, the thermoregulation was discussed. In the current study, we tried to maintain normothermia throughout the perioperative period; however, the lower body temperature, the higher grade of shivering existed. Among other reasons for shivering was gender; some studies reported no relationship and some found males more prone to shivering [3], [13], [21]. Contradictory to these results, in our study, a higher stage of shivering happened for the female; this may have happened because of the type of surgeries in this study. A few researchers have found that less use of opiates can cause more shivering, as well as we know that pain threshold is higher in women and indeed BIS monitor would show a less score for a woman suffering from a pain compare to a man in the same situation [7], [9]. It has been previously shown that patients who underwent anaesthesia with Pentothal experience a higher incidence of postoperative shivering compare to propofol [2], [22].

Furthermore, using halogenated agents seemed to cause more post-op shivering. Lewis et al. did one study on the effects of alpha2-adrenergic agonists on inhibition of post-op shivering [23]. In their study has been shown that clonidine and dexmedetomidine had a positive effect on decreasing post-op shivering. Our protocol for anaesthetising patients was a standard and normal balanced approach which was equal for all of our cases. We used thiopental sodium for induction to avoid any biases about propofol and its probable anti-shaking effects. Also, administering of the opiates and benzodiazepines for patients was according to their BIS level. Some clinicians prefer to use drugs according to heart rate, blood pressure, lacrimation and other motor sensory signs. However, in our study to avoid any bias and diminish individual decisions, the BIS score was the guide for drugs, and it should have been maintained between 40 and 60. The result of a study aiming to evaluate different pharmacological classes to decrease post-operative

shivering indicated among the drugs which affected shivering, pethidine was the best [23]. Our study was limited to one centre; further studies with different surgeries and a more population are suggested.

In conclusion, the results of this study indicate a significant inverse association between BIS value and postoperative shivering in patients undergoing orthopaedic surgery, so that, patients with higher BIS score experienced significantly more postoperative shivering. It seems that BIS-guided anaesthesia can reduce the risk and incidence of postoperative shivering in patients undergoing orthopaedic surgery.

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