ASSESMENT OF THE NEED FOR ANESTHETICS BY BIS MONITORING DURING "OFF-PUMP" CORONARY ARTERY SURGERY

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***Objective:** To compare the anesthetic requirements and duration of extubation in off-pump coronary artery surgery with or without BIS monitoring.*
***Method:** A total of 21 patients were included in this prospective study. The patients were randomized into two groups. BIS monitoring was used for the study group.*
***Results:** The dose of inhalational and intravenous anesthetic agents administered was lower in the study group. Also, the duration of extubation was lower in the study group.*
***Conclusion:** BIS monitoring can lower the dose of anesthetic agents required during off-pump coronary artery surgery by facilitating dose titration.*

***Key words:** Off-pump, bispectral index, anesthesia*

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Early recovery and extubation with the minimal use of anesthetics that provide effective sedation and amnesia are the goals of modern anesthesia. Hence, bispectral index (BIS) monitoring is being more frequently used in cardiovascular surgery.

A novel technique introduced after 1990's, the BIS monitoring, has allowed objective measurement of the level of amnesia and sedation achieved by the commonly used inhalational and intravenous anesthetic agents (1). BIS can objectively assess the sleep status of the patient in a scale between 0 and 100 as the derivatives of the association between the phase and frequency of electroencephalographic waves (1,2).

The objective of off-pump coronary artery bypass (OPCAB) graft surgery is to avoid potential adverse consequences including the activation of complement, neurocognitive dysfunction and the coagulation disorder that can develop during cardiopulmonary bypass surgery. In addition, anesthesia applied during OPCAB can allow for early extubation and recovery, and can reduce the cost. In this study, we aimed at comparing the anesthetic requirements and duration of extubation in off-pump coronary artery surgery with or without BIS monitoring.

METHODS

A total of 21 ASA II-III patients undergoing off-pump coronary bypass surgery were included in this prospective, randomized study. Prior to cardiovascular surgery, hemodynamic instability and the need for emergency surgery after catheterization precluded participation. The failure to place a stent in single-vessel disease, bypass in single vessel, atheromatous disease of the aorta, and significant renal, hepatic, pulmonary and/or central nervous system disorders were the indications for OPCAB as in many other centers.

Patients received 5 mg of oral diazepam on the night before the surgery. An intravenous line was placed when the patients were transferred to the operating room, and 2 mg of midazolam was administered. The patients were randomly assigned into two groups: the control group (n=10) and the study group (n=11). Patients in the study group were monitored by a BIS monitor (AspectTM model A-2000, Medical System, Natick, MA USA) and BIS sensor electrodes. Following radial catheterization, 3 mcg/kg of fentanyl, 2mg/kg of propofol and 1 mg/kg of %2 lidocaine were given for the induction and, 0.1 mg/kg vecuronium for the intubation. The intubation was performed in accordance with the BIS values in the study group, whereas hemodynamic parameters and clinical signs were used for the timing in control patients. Opioids (intermittent bolus fentanyl) and inhalational anesthetics (isoflurane, end-tidal, between 0.6 and 1.0) were used for the maintenance. Isoflurane was given at a rate of 4 l/min in O2. For the titration of the maintenance dose, a BIS value of below 55 was targeted in the study group, and clinical signs and hemodynamic parameters were used in the control group as for the intubation.

A low dose nitroglycerine infusion and low dose heparinization (1-1.5 mg/kg) at an ACT of > 250 were utilized to prevent ischemia during OPCAB. The internal mammary artery was used in all patients. Pharmacological stabilization during distal anastomosis was performed by metoprolol (2.5-5 mg, bolus) and diltiazem (0.1 mg/kg/h, infusion). The effect of heparin was neutralized by protamine after proximal anastomosis. The protamine dose was administered at a ratio of 1:1. ACT, the patency of the graft and the adequacy of the homeostasis were checked. The hemodynamic parameters were supported by dobutrex/nitroglycerine in order to maintain a difference of 20% compared with the basal values.

At the end of the surgery, the total dose of opioids and muscle relaxants used during the maintenance was recorded. The total dose of isoflurane used was calculated by the following formula according to the vaporisator (agent specific variable-bypass vaporisator, Julian Drager Vapor 19.3):

The anesthetic agent used (ml/h)= 3 x fresh gas flow (L/min) x volume %

The patients were intubated when they were transferred to intensive care unit, and extubation was performed according to the early extubation criteria (Table I).

Table I:Early extubation criteria

Body temperature (nasopharengeal temperature)>35.5°C
Completely awake
No respiration problem
- Respiration rate <20 /min
- PaCO2 <50 mmHg
- PH >7.3
- FiO2 <%50 and SaO2 >%94

Hemodynamic stability
No aritmies
Chest drainage <100ml/hr

The statistical analyses were performed with SPSS (Statistical Package for Social Sciences) for Windows 10.0. The study data were assessed by descriptive statistical methods (mean, standard deviation), and the qualitative data were compared with Student's t test and Mann Whitney U test. The results are expressed with 95% confidence intervals and the level of significance was set at p values lower than 0.05.

RESULTS

The two groups were similar with regard to the demographic characteristics ($p > 0.05$) (Table II).

Table II: Demographic characteristics

	Control group	Study group	p
Age	64,90 – 6,19	64,27 – 6,92	0,830; p>0,05
Weight (kg)	79,20 –11,52	77,63 –12,22	0,767; p>0,05

Also, there were no significant differences between the two groups with regard to the duration of operation and the total duration of distal anastomosis ($p > 0.05$) (Table III).

Table III: Operational data.

	Control	Study	P
Total distal anastamosis time (minute)	18,70–3,56	17,09–3,61	0,318; p>0,05
Operation time (minute)	168,0–21,49	169,54–29,44	0,893; p>0,05

* p<0,05 significant difference
** p<0,001 high significant difference

The dose of muscle relaxants did not differ significantly between the two groups ($p > 0.05$) (Table IV). However, the dose of opioids used in the group with BIS monitoring was significantly lower when compared to the control group ($p < 0.05$) (Figure 1) (Table IV).
Also, the volume of inhalational anesthetic used was highly significantly lower ($p < 0.001$) (Figure 2) (Table IV), and the duration of extubation was substantially shorter in the study group ($p < 0.001$) (Figure 3).

Table IV: Amount of Anesthetics Used and Extubation Time.

Muscle relaxants (mg)	8,40–2,01	8,0–2,0	0,653; p>0,05
Opioid amount (mgr)	355,0–89,59	254,54–75,67	0,012; p<0,05*
Inhalational anesthetics (ml)	34,50–3,65	27,18–2,13	0,001; p<0,001**
Extubation time (minute)	180,0–32,40	105,90–19,21	0,001; p<0,001**

* p<0,05 significant difference
** p<0,001 high significant difference

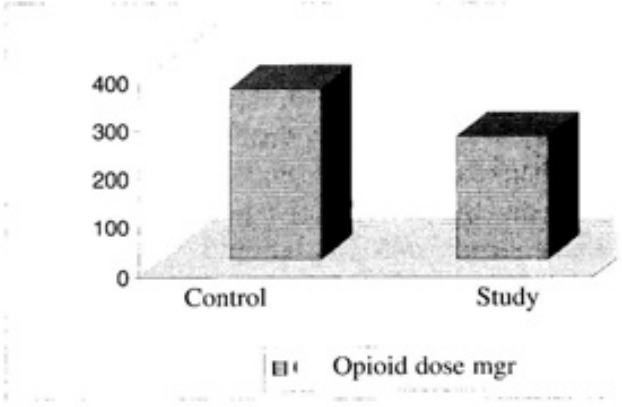

Fig 1: Opioids amounts in groups(gr)

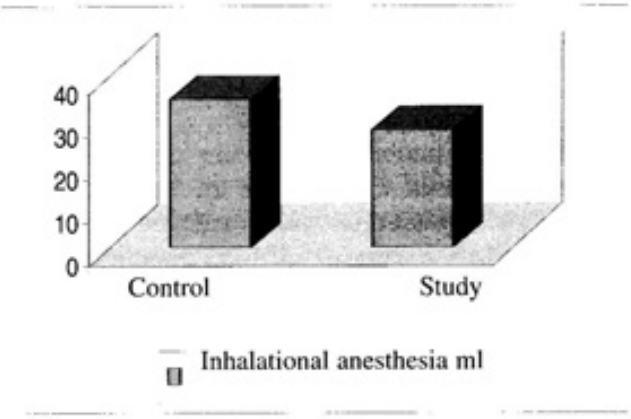

Fig 2: Inhalatinal anesthetics in groups (ml)

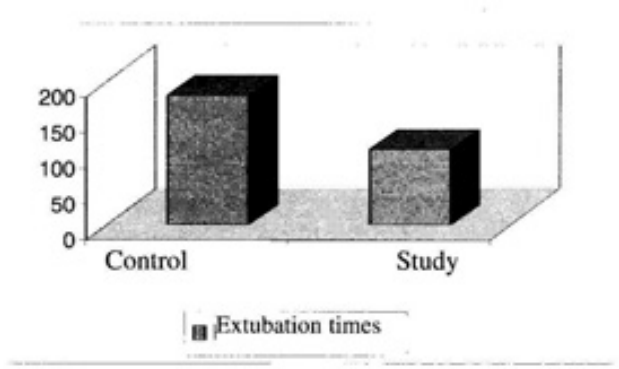

Fig 3: Extubation times in groups (minute)

DISCUSSION

Anesthesia during off-pump coronary artery surgery is a relatively distinct entity for the anesthesiologist with regard to its indications, usage and the postoperative goals. Patients with major organ failures should be protected against potential complications that can arise from the coronary bypass technique. Beta-blockers and calcium antagonists are used in order to provide pharmacological stabilization during the completion of anastomoses. On the other hand, postoperative goals are to achieve earlier recovery and extubation, and to lower the cost in cases without a change in coagulation parameters and temperature in relation to the extracorporeal circulation (3,4).

In this study, the BIS index was kept at below 55 in patients with BIS monitoring. Previous studies suggest that the anesthetic sedation is sufficient when the BIS index is equal to or below 60 in patients who were given opioids and inhalational anesthetics. In the study by Johansen, "awareness" has been reported by 0.003% of more than 1 million cases; in half of these patients, the BIS value was > 65 (6). Barr et al. observed no cases with "awareness" among patients with a BIS value less than 55. In line with the previous data (5,7,8), none of our patients reported recollection of auditory stimuli (music, conversation etc.) or unpleasant memories upon inquiry regarding the time of surgery. The BIS value was kept below 55 in all cases, and satisfactory sedation was maintained without a state of "awareness".

The decrease observed in the mean blood pressure and heart rate when metoprolol and diltiazem were administered for pharmacological stabilization suggests that assessment of the depth of anesthesia on the basis of hemodynamic parameters is inadequate. The balance between the vasoactive and anesthetic agents was much more easily established in the group with BIS monitoring with regard to hemodynamic stabilization and anesthetic sedation. Various authors draw attention to a possible suppression of clinical indicators of sufficient anesthesia by beta-blockers, changes in blood volume and muscle relaxants in spite of hemodynamic stability and absence of awareness (9). Hypertension is frequently seen in patients with coronary artery disease as a complication of related disorders. In this group of patients with elevated hemodynamic parameters, objective assessment of the depth of anesthesia with BIS monitoring allowed for a better stabilization of hemodynamic parameters by increasing the dose of vasodilators rather than increasing the dose of anesthetics.

It has been suggested that although there is a significant correlation between the "BIS index" and hypnosis, sedation and the state of awareness in relation to the depth of anesthesia, this method does not exhibit a similar correlation with the hemodynamic parameters, the body movements and the change in blood pressure, which are among the other indicators of the depth of anesthesia (10,11). However, depending on the type and dose of anesthetic agents, an association between the BIS index and the other parameters of the depth of anesthesia has been shown to exist. In Sebel's work (12) increasing the concentrations of propofol and isoflurane were associated with a decrease in BIS index and in movements with painful stimuli. In the same study, increasing doses of opioids were associated with decreased movements with painful stimuli, but a significant correlation with BIS index could not be established.

In our study with a similar array of agents, we believe that interpreting these parameters only by BIS would be inappropriate, since vasoactive and anesthetic agents were used simultane-

ously. However the agents used for induction (3 mcg/kg of fentanyl, 2 mg/kg of propofol) and maintenance (0.8-1% of isoflurane) of anesthesia, as well as the BIS values correlated well with other parameters of the depth of anesthesia. No significant hemodynamic changes and clinical response to painful stimuli were observed when the BIS index was between 55 and 30.

When the total doses of medications were compared at the completion of surgery, the anesthetic dose administered in the study group was lower than the control group: 254.54 ± 75 µg and 355.0 ± 89.59 µg of fentanyl; and 27.18 ± 2.13 ml and 34.50 ± 3.65 ml of isoflurane respectively. Early extubation was performed with early extubation criteria (9) in patients for whom the effect of muscle relaxants could not be reversed. The extubation time was significantly shorter in the study group ($p > 0.001$), for which the dose of anesthetics administered was also lower. Our results, being similar to those of other studies in which volatile anesthetics were used alone (12,13,14) or in combination with opioids (12,15,16), indicate that BIS monitoring is necessary in OPCAB anesthesia.

CONCLUSION

To conclude, BIS monitoring used during OPCAB anesthesia provides a reliable and objective method for assessing the adequacy of sedation compared to clinical indicators which are likely to be suppressed by other pharmacological agents, thus preventing the use of excess doses of anesthetics and allowing for earlier recovery and extubation, and helping to reduce the costs associated with such procedures.

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