Journal of Clinical Anesthesia (2005) **17**, 509–516

ELSEVIER

Journal of Clinical Anesthesia

Original contribution

Influence of bispectral index monitoring on decision making during cardiac anesthesia

George Vretzakis MD (Assistant Professor)[a], Eleni Ferdi MD (Anesthesiologist)[a], Helena Argiriadou MD (Anesthesiologist)[a], Basilios Papaziogas (Lecturer)[b,*], Dimitrios Mikroulis MD (Cardiac Surgeon)[c], Miltiadis Lazarides MD (Cardiac Surgeon)[c], George Bitzikas MD (Cardiac Surgeon)[c], George Bougioukas MD[c]

[a]*Department of Cardiac Anesthesia, University Hospital of Alexandroupolis, 68100 Alexandroupolis, Greece*
[b]*2nd Surgical Clinic, Aristotle University of Thessaloniki, 54635 Thessaloniki, Greece*
[c]*Clinic of Cardiac and Thoracic Surgery, Democritus University of Thrace, 68100 Alexandroupolis, Greece*

Received 5 January 2004; accepted 1 December 2004

Keywords:
Bispectral index monitoring;
Cardiac anesthesia;
Decision support;
Hypothermia

Abstract

Study Objective: To assess bispectral index (BIS) monitoring on decision making during cardiac surgery with cardiopulmonary bypass (CPB) by measuring the number of preset standardized comments with and without knowing the BIS value and by classifying the interventions following the BIS data.

Design: Prospective, randomized study.

Setting: University Hospital.

Patients: One hundred twenty-one patients scheduled for elective cardiac surgery (89 coronary patients, 24 valve replacement patients, and 8 valve replacement and coronary surgery).

Interventions: Patients were divided into 3 groups. An observing anesthesiologist recorded on a special form ("parallel" anesthesia record) data from the devices of the workstation and the BIS monitor. Conditions in which BIS monitoring was subjectively considered that might have been useful in anesthetic decision making were recorded as "events." In group A (36 patients), the responsible anesthesiologist had continuous access to BIS information. In group B (44 patients), intraoperative anesthetic management was "blinded" to BIS values, whereas in group C (41 patients), the anesthesiologist observing the BIS monitor was free to inform the attending anesthesiologist about the BIS score. The number of events was considered as negatively reflecting the quality of the clinical course of a patient. The reduction of events was considered as improvement in decision making. All patients received the same anesthetic regimen (propofol + remifentanil). Monitoring was equal in all cases. Mild hypothermic CPB was applied in 73 patients. Statistical analysis used 1-way analysis of variance, Student 2-tailed t test, and χ^2 analysis.

Main Results: Patient demographic data, underlying pathology, operation performed, hypothermia application, times of anesthesia, duration of operation, and CPB were similar in the 3 groups. In group B, the BIS value was considered by the observer as useful to know in 220 events (5.00 ± 1.58 per patient). In group C, the BIS value was considered by the observer as useful to know in 143 events

* Corresponding author. 551 33 Thessaloniki, Greece. Tel.: +30 2310 992562; fax: +30 2310 992563.

0952-8180/$ – see front matter
doi:10.1016/j.jclinane.2004.12.018

(3.49 ± 1.31 per patient, $P < 0.001$) and, at the same time, the attending anesthesiologist was informed about BIS. In 112 (78.3%) cases, measures were taken. Titration of anesthetic drugs was done in 79 (70.5%) patients, whereas titration of vasoactive drugs was done in 9 (8.0%) patients, titration of both in 13 (11.6%) patients, and other diagnostic or corrective actions in 11 (9.8%) patients. Distributions of BIS values did not differ statistically (39.19 ± 10.32, 37.38 ± 10.21, and 38.29 ± 10.01 in group A, group B, and group C, respectively). "Zenith" and "nadir" BIS values after induction also did not differ statistically. Awakening and extubation times were similar in both groups.

Conclusions: Subjectivity, although reduced as much as possible, can play a confining role in the value of our results. The usefulness of BIS monitoring is shown by the fact that BIS data resulted in corrective measures. Attending anesthesiologist's actions, based on BIS information, reduced the events in group C.

1. Introduction

The bispectral index (BIS) offers a simple method for continuous brain status monitoring throughout the administration of anesthetic or sedative drugs. Bispectral index monitoring is considered a reliable tool in assessing the level of consciousness. It is currently accepted that induction and maintenance of anesthesia are associated with a decrease in BIS value, and that increasing concentrations of either volatile or intravenous anesthetics further decrease the BIS value. This measurement of the hypnotic effect proved to be accurate and reliable in nearly all patients and clinical settings. The use of BIS monitoring has grown rapidly in the care of patients, as it is safe and inexpensive and it does not require special training.

During cardiac surgery, one of the aims of anesthetic management is to achieve a level of adequacy that eliminates the stress response, without unjustifiably prolonging the postoperative mechanical support of breathing. In these operations, the result of anesthetic drugs may be affected by various factors. Acute and significant fluctuations in plasma drug concentration as a result of priming, alterations in the rate of diuresis or in the concentration of binding proteins, modification of the function of organs contributing to drug metabolism, and temperature fluctuations are some of the factors that may alter drug kinetics or affect the pharmacodynamic action of anesthetic or sedative administration. Furthermore, the relation between the hypnotic and analgesic depth and the usual clinical criteria of their estimation is unclear because of the administration of various drugs such as catecholamines and β-blockers, among others, and because of the manipulations in the central circulation. All of the above, combined with the problem of "awareness" and the benefits of early extubation, justify the application of BIS monitoring in assessing the patient's hypnotic state. Nevertheless, its utility during cardiac operations and its role on decision making are unclear. This study aimed to determine whether BIS monitoring enhances decision making as measured by standardized comments and interventions following the knowledge of BIS value.

2. Materials and methods

2.1. Patient data, anesthesia, and operation

After receiving protocol approval by the Ethical Committee of the University Hospital of Alexandroupolis/Greece, we initially enrolled into the study 130 patients who were scheduled for elective cardiac operations. Those patients undergoing "off-pump" techniques and those with significantly compromised left ventricular function in the preoperative evaluation were excluded from the study. In all patients, ejection fraction (EF) was greater than 45% (mean EF, 49.5% ± 4.6%) as measured by preoperative angioventriculography. Patients scheduled for a combined carotid endarterectomy procedure were also excluded from the study.

Premedication consisted of diazepam 10 mg given orally 1 hour before admission to the operating room (OR). On arrival in the OR, patients were connected to standard monitoring (Solar 8000, Marquette Medical Systems, Milwaukee, Wis) and a peripheral intravenous catheter and a radial intra-arterial catheter were placed. Intraoperative electrocardioscopy consisted of 5-lead, ST-segment analysis. Anesthetic induction was achieved with a slow, single-dose administration of midazolam (1-3 mg) plus fentanyl (100-250 μg) plus etomidate (0.2 mg/kg) and neuromuscular blockade with pancuronium (0.12 mg/kg). After tracheal intubation, all patients were placed on mechanical ventilation (Julian, Dräeger, Lübeck, Germany) that was targeted to slight hypocapnia (33 mm Hg < $PaCO_2$ <37 mm Hg), based on repeated arterial blood gas sampling. Inspiratory fraction of oxygen in air was between 0.5 and 1.0. For the anesthesia maintenance, patients received a propofol infusion targeted to a 3-μg/mL plasma concentration, facilitated by a pump (Fresenius, Vial, Brezins, France). Infusion rates were manually calculated to ensure a stable concentration during the next 30 minutes, that is, the time necessary for further anesthetic and surgical preparation. A continuous infusion of remifentanil ($\approx$ 20 μg/kg per hour) was also administered as a means of providing analgesia. The attending anesthesiologist was free to change those rates during the procedure. The insertion of a triple-lumen