Case Report

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Usefulness of the bispectral index during cardiopulmonary resuscitation
-A case report-

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The usefulness of using the bispectral index (BIS) for monitoring during cardiopulmonary resuscitation (CPR) is not clearly understood. However, BIS has been a popular anesthetic monitoring device used during operations. The case presented is of a pregnant woman going into cardiac arrest due to an amniotic fluid embolism during a Cesarean section. CPR was performed, but neither the return of spontaneous circulation (ROSC) nor the return of consciousness was achieved, despite 50 min of effective CPR. However, CPR was continued based on BIS. ROSC was achieved, and an alert consciousness state was reached 1 day postoperation. This finding suggests that BIS be used as a basic monitoring device during CPR and that it may help in deciding to continue CPR. (Korean J Anesthesiol 2013; 64: 69-72)

Key Words: Bispectral index, Cardiopulmonary resuscitation, Consciousness.

Cardiopulmonary resuscitation (CPR) is frequently conducted on cardiac arrest patients. However, the question of how long to maintain cardiac massage for CPR when the heart rhythm has not returned to a normal sinus rhythm has been a persistent as dilemma facing anesthesiologists. In the present case, cardiac arrest was caused suddenly by an amniotic fluid embolism during a Cesarean section on the patient monitored by bispectral index (BIS). There was no response to CPR for over 30 min; however, CPR was continued for approximately 50 min, due to the BIS score, which ranged from 40 to 60.

This case presents the return of spontaneous circulation (ROSC) and an alert mental state after 50 min of CPR, as guided by BIS monitoring.

Case Report

A 40-year-old woman (161 cm, 67 kg) at 36 and 6/7 weeks gestation with placenta previa totalis, visited the hospital for a Cesarean section. She had delivered her first baby by Cesarean section roughly 10 years earlier. The patient had a myomectomy 9 years earlier, due to myoma in the low portion of uterus. The results of the preoperative laboratory tests were

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normal. Invasive arterial blood pressure monitoring was started before anesthesia, due to the anticipation of a large amount of intraoperative bleeding by placenta previa.

Anesthesia was induced with intravenous injection of thiopental sodium 250 mg and succinylcholine 66 mg. After a successful intubation, anesthesia was maintained with sevoflurane 1.2 vol% and 50% nitrous oxide. The patient was ventilated by a volume-controlled mode with 50% oxygen. Monitoring devices, such as electrocardiogram (EKG), BIS, and pulse oximetry were used. The ventilator was set to end-tidal carbon dioxide ($EtCO_2$) partial pressure 30−35 mmHg.

After intubation, an additional 25 mg atracurium was injected intravenously. The baby was delivered 9 min after the induction of anesthesia. The baby's Apgar scores at 1 and 5 min were 8 and 9 points, respectively. There were no complications with the fetus. After the placenta was removed, bleeding was observed in the uterus at placental attachment sites. An intravenous injection of 0.2 mg methyl ergonovine for uterotonic effect, and a central venous catheter was inserted in the right internal jugular vein. Packed RBCs were administered through a central venous catheter, and the patient's vital sign remained stable (systolic and diastolic blood pressure 110−120/70−80 mmHg, heart rate 75−85 beats/min, BIS 50−65).

The surgeon finished the uterine suture one hour and 40 minutes after the operation. At that time, the patient's $EtCO_2$ partial pressure and blood pressure dropped abruptly. $EtCO_2$ partial pressure was 15 mmHg, systolic blood pressure was 60 mmHg, SpO_2 was 90% and ventricular fibrillation appeared. The operation was stopped immediately, chest compression was started, and additional help was requested.

Defibrillation using biphasic defibrillator in 200 Joule was attempted; epinephrine, atropine, and bicarbonate were injected; and chest compression was continued. However, the patient's normal sinus rhythm did not return. Fortunately, systolic blood pressure was maintained at approximately 60−100 mmHg, depending on the cardiac compression. Despite manual ventilation with 100% oxygen, the patient's arterial oxygen saturation was 86%, as checked by arterial blood gas analysis (ABGA). Additionally, a significant amount of a blood-like secretion exited the endotracheal tube and $EtCO_2$ partial pressure was checked as apnea (PH 7.32, $PaCO_2$ 35 mmHg, PaO_2 56 mmHg, HCO_3^- 18.0 mmol/L, and SaO_2 86.0%). However, BIS values were maintained above 40. Cardiac compression was attempted for 40 minutes, defibrillation was performed three times and epinephrine 60 mg, atropine 5 mg, bicarbonate 120 mEq, calcium chloride 1,200 mg were used. The heart rhythm did not return, despite BIS values remaining above 40 during CPR. CPR was not stopped.

Due to the vigorous flow of blood-like secretion from the endotracheal tube, the corrugating tube was exchanged five times, $EtCO_2$ partial pressure monitoring was stopped, and the tube was continuously suctioned. Manual ventilation was maintained with 100% oxygen. After 50 min of CPR, there was an abrupt return of a normal sinus rhythm. The patient's blood pressure was 90/50 mmHg, and her heart rate was 110 beats/min. Twenty percent mannitol 100 ml, lasix 20 mg, and methylprednisolone 500 mg were injected intravenously to protect the vital organs. Obstetricians completed the operation by re-stitching the wound. There was no urine output during CPR, but urine was excreted at a rate higher than 200 ml/hour once spontaneous circulation was restored.

No uterine bleeding was observed by the naked eye through a vaginal speculum, and a hysterectomy was not performed. However, after an hour, the patient developed vaginal bleeding, and her heart rate increased to 120−130 beats/min. Therefore, a hysterectomy was performed, and a transesophageal echocardiography (TEE) probe was inserted. The thrombus in the heart was not found, but there was global hypokinesia in the left ventricle. The results of the lab measurements were a platelet count of 39,000, a prothrombin time (PT) of 28.6 sec, an activated partial thrombin time (aPTT) of 129.1 sec, fibrinogen at 60 mg/dl, and a d-dimer > 20 μg/ml. A disseminated intravascular coagulation (DIC) by amniotic fluid embolism was suspected, and 3 units of whole blood, 10 units of pack cells, 20 units of platelets, and 10 units of fresh frozen plasma were transfused during the surgery. Total anesthesia time was 8 hours and 40 minutes.

After the surgery, the patient was transferred to the intensive care unit. Chest radiography showed pulmonary edema in both lungs. She was treated with transfusion and fluid therapy, due to a suspected DIC by amniotic fluid embolism. Two hours after the operation, she recovered to a drowsy state and responded to pain stimulation.

Six hours after the operation, the pulmonary edema showed a slight improvement on chest radiography, and a transthoracic echocardiography (TTE) in the intensive care unit revealed no obvious regional wall motion abnormality. Although breathing with a ventilator, she returned to an alert mental state and was cooperative sixteen hours after the operation. Extubation was performed, and vital signs were stable. (pH 7.605, $PaCO_2$ 25.3 mmHg, PaO_2 98.5 mmHg, HCO_3^- 24.6 mmol/L, and SaO_2 98.4%, hemoglobin 9.9 g/dl, platelet 108,000, PT/aPTT, 16.6/48.5 sec, fibrinogen 263 mg/dl, d-dimer 4.51 μg/ml)

Thirty min after the extubation, the patient experienced a sudden loss of consciousness, and cardiac arrest developed again. Once defibrillation was performed, her mental state and heart rhythm recovered immediately. After seven hours, she showed tachyarrhythmia and cardiac arrest. Five days after surgery, the patient's condition continued to deteriorate, and she developed multi-organ failure. Thus patient was

supported by extracorporeal membrane oxygenation (ECMO) and continuous renal replacement therapy (CRRT). Despite aggressive resuscitation, she died 6 days after the surgery.

Discussion

When ROSC is not restored during CPR, it is difficult for the anesthesiologist to determine for how long to perform cardiac massage. Cardiac arrest can be divided into 2 subgroups: in-hospital arrest and out-of-hospital arrest. The rate of discharge after an out-of-hospital arrest is known to be less than 5% [1]. When all patients are delivered to the hospital, the cost to the patient increases, and the risk of traffic accidents by the emergency medical team also increases. Morrison et al. [2] set the rule that if there was no ROSC after CPR performed by emergency medical team, no AED shock was administered before transport, and the arrest was not witnessed by the emergency medical team, CPR was to be terminated and the patient was not to be delivered to the hospital. However, survey of 1,240 patients of out-of-hospital arrest reported that all patients were delivered to the hospital, where they received CPR. Only 4 out of 776 patients suitable for CPR termination rules survived. This study reported the positive predictive value of patient mortality of those who agreed to the criteria to be 99.5%. Sasson et al. [3] reported that in instances of no shock prior to transport, no witnessing of the arrest by bystanders or emergency medical personnel, and no CPR administered by a bystander, the survival rate of advanced life support recipients subjected to termination of resuscitation criteria performed in the absence of ROSC was 5 out of 2592. Additionally, 1,192 patients subjected to advanced life support termination criteria were all expired.

However, during an in-hospital arrest, the emergency medical team is nearby, and an emergency medical device can be accessed more quickly. This access accounts for the discharge survival rate of in-hospital arrests of 10−15% to be slightly higher than out-of hospital arrests [4]. Schultz et al. [5] reported that among 266 in-hospital arrests, 75 patients (28%) had ROSC, and twenty-four (32%) of the 75 patients with ROSC (representing 9% of the CPR recipients) survived and were discharged from the hospital. Factors that predict a poor outcome following CPR in the case of in-hospital arrests included age greater than 60, co-morbid disease (i.e., pneumonia, sepsis, renal failure, or heart disease), and an initial $PaO_2 < 50$ mmHg and CPR efforts extending beyond 10 min [5]. Bedell et al. [6] reported that none of the 179 patients in its study for whom resuscitative effort lasted longer than 30 min survived to be discharged. The case presented is concerned with the termination of CPR due to the hypoxemia (PaO_2 56 mmHg) during cardiac arrest. CPR duration exceeded 40 min, and a blood-like secretion was suctioned through endotracheal tube, but the patient's spontaneous circulation did not return. Because the cardiac arrest occurred in a young pregnant woman, and the BIS score was maintained above 40 continuously during CPR, CPR was continued, and the patient returned to an awakened state of consciousness 1 day postoperation. More aggressive approaches to resuscitation, such as ECMO, cardiopulmonary bypass, and intra-aortic balloon counterpulsation, could have been implemented at the time of collapse. However, because the patient's neurological complication, mortality, and morbidity were related to the prolonged CPR [7], these approaches were not taken.

BIS is a noninvasive procedure for monitoring hypnotic drug effect during anesthesia [8]. BIS is a parameter derived from EEG and can therefore illustrate cerebral blood flow status. Because BIS is a real-time indicator of brain function, it may be useful as a clinical monitoring tool for predicting the prognosis of post-cardiac arrest outcomes, such as brain damage. However, the usefulness of BIS during cardiopulmonary resuscitation is a controversial topic. Shibata et al. [9] have reported the usefulness of BIS in predicting post-resuscitative outcome after ROSC in patients that experience out-of-hospital arrest. Kluger [10] reported that ROSC was restored 25 min after chest compression in an anaphylactic shock patient. The BIS value was maintained above 40 throughout the procedure, and consciousness was recovered after 3 hours with no neurological deficit. However, Chollet-Xémard et al. [11] reported BIS values during out-of-hospital CPR not to be predictive of recovery of spontaneous cardiac activity, not be correlated with end-tidal CO_2 during resuscitation and that early BIS values in the patients who returned to spontaneous cardiac activity after initial resuscitation are not a predictor of survival. BIS maintained above 40 and achievement of an alert mental state after ROSC in the case presented demonstrates the potential usefulness of BIS during cardiopulmonary resuscitation.

Amniotic fluid embolism (AFE) is a rare and fatal obstetric event. The incidence of AFE is unknown but it is estimated at 1/8,000−80,000 deliveries [12]. The pathophysiology of AFE is also poorly understood. In the past, it was thought that AFE was characterized by the presence of amniotic fluid debris in the maternal pulmonary circulation. However, Lee et al. [13] demonstrated that fetal cells can be found in the blood of normal parturient women and that they did not produce clinical symptoms similar to those of AFE. Other investigators have reported an inability to reproduce the AFE in animal models by injection of amniotic fluid directly into circulation [14]. Clark et al. [12] demonstrated that AFE is a type of anaphylactic shock related to various cytokines and immunological factors. Clinical features and presenting signs and symptoms of AFE included acute hypotension or cardiac arrest, acute hypoxia, coagulopathy. In addition, AFE occurred during labor, after

vaginal delivery, and during Cesarean section after delivery of the fetus [12,15]. This patient was also diagnosed as having AFE based on typical clinical aspects, including the sudden hypotension due to cardiovascular collapse, hypoxia and subsequent coagulopathy. However, echocardiography did not find evidence of a thrombus in the heart.

Although ROSC could not be anticipated, if the blood pressure and BIS were maintained well with cardiac compression, as observed with the present case, continuous CPR efforts should be continued for over 30 min because restoration of an alert mental state can be expected after ROSC. We also recommend BIS as a basic monitoring device, as well as EKG, during CPR.

In conclusion, BIS monitoring might be used as a reference device to determine whether CPR should be continued.

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