A Combined Strategy of Sedation Guided by Bispectral Index, ICP Monitoring and Mild Hypothermia to Deal with Refractory Intracranial Hypertension: A Case Report

Cao C, Gao H*, Wu W, WangHX, Yang L, Yan KX, Huang LP and Lu YP
Department of Neurosurgery, The Affiliated Jiangyin Hospital, School of Medicine, Southeast University, Jiangyin City, Jiangsu Province, P.R China

Abstract

Traumatic brain injury (TBI) has become a worldwide public health problem due to its high mortality and morbidity. Refractory intracranial hypertension (ICH), secondary to TBI, always results in poor prognosis and sometimes even death. Sedation, intracranial pressure (ICP) monitoring and mild hypothermia have been proven effective in monitoring and controlling ICH after TBI. Here we present a case of 55-year-old male suffering from acute TBI.

Keywords: Intracranial hypertension; Traumatic brain injury

Introduction

Bispectral index (BIS) is widely used to monitor the depth of anesthesia during surgery [1,2]. BIS is also used as a tool to assess the sedation depth of TBI and guide the use of sedatives in some studies [3-5]. In this study, we presented a patient with refractory ICH due to TBI, and treated him with a combined strategy of sedation guided by BIS monitoring, ICP monitoring and mild hypothermia, a strategy producing a favorable outcome.

Case Presentation

A 55-year-old male was admitted to our department suffering from acute TBI due to a fall accident from a high place 2 hour previously. He was unconsciousness with GCS 11 (E3V3M5), and his pupillary light reactions showed equal and reactive pupils on both sides. The neurological examination was negative. A computed tomography (CT) scan showed cerebral contusion of his bilateral temporal lobes and left occipital lobe. After admission, he was treated with the first-tier treatments to reduce ICP: reverse trendelenburg, oxygen therapy, measures to maintain PaCO2, 4.5-5.0 kPa and so on. A second CT scan was taken 6 hours later, which showed an aggravation of his left temporal contusion, accompanied by increased confusion. More aggressive treatments were applied, including an ICP probe (Codman, Johnson and Johnson, USA) being implanted into the cerebral cortex via the right frontal. His ICP was as high as 23 mmHg (1 mmHg=0.133 kPa). Sedation induced by dexmedetomidine (induction: 0.4 ug/kg; maintenance: 0.08-1.0 ug/kg/hour), midazolam (induction: 0.1 mg/kg; maintenance: 0.02-0.2 mg/kg/hour), and propofol (induction: 2 mg/kg; maintenance: 0.4-4.0 mg/kg/hour) was also used to reduce ICP, and we applied BIS monitoring to guide the sedation level (BIS 40-60). The BIS was measured with a BIS monitor continuously (Aspect Medical System, Newton, MA, USA). A BIS-Quatro electrode was placed on the right forehead. During the monitoring, the indicators such as signal quality index (SQI) and electromyography activity (EMG activity) were observed. We maintained SQI>80% and EMG <50 dB in order to achieve reliable BIS values. In the next two days the patient’s ICP was lower than 25 mmHg. However, his ICP increased to more than 30 mmHg for more than 30 minutes. Another CT scan showed aggressive cerebral edema, and the basal cistern was narrow. Decompressive surgery may be one of the best options to rescue ICH, but his authorizer refused the option of removing the mass to relieve ICH. A further application of mild hypothermia (maintaining a core temperature of 34–35°C) was conducted to reduce refractory ICH.

Mild hypothermia was induced by an ice blanket machine (HGT-200, HOKAI, Zhuhai, China). Our goal was trying to keep the ICP value less than 25 mmHg. BIS monitoring interval was still maintained between 40 and 60 to guide the depth of sedation. ICP monitoring and intermittent CT scans were used to assess the cerebral edema and the shape of the basal cistern. This aggressive therapy strategy combined of sedation guided by BIS, ICP monitoring and mild hypothermia lasted 2 weeks. On his 40th day of hospitalization, he discharged with a GOS of 4/5, and his follow up showed total recovery.

Discussion

Refractory ICH is the most common issue leading to an unfavorable outcome after TBI. In order to control the refractory ICH, several measures can be applied, including sedation, ICP monitoring and mild hypothermia [1]. Although sedation is necessary for severe TBI patients, we were unable to come to an agreement on how to monitor the sedation level of TBI.

The Richmond Agitation-Sedation Scale (RASS) and Sedation-Agitation Scale (SAS) are most often used to monitor the sedation level after TBI [2]. But neither of them was totally suitable for TBI because of its subjectivity. In addition, evaluating accurately is difficult because of unconsciousness after TBI.

So, it’s significant to find an objective measure to monitor and evaluate the sedation level after TBI. And it’s also meaningful to achieve an ideal sedation level effectively by this means.

Electroencephalography (EEG) can be used to monitor the sedation level, and it had been used in the study of barbiturate therapy, which can reduce refractory ICH after TBI [1]. However,
long-term EEG monitoring has not been widely used because it is so specialized. Quantified EEG monitoring is more accessible than EEG. BIS is a quantified parameter derived from EEG, and it provides a dimensionless number that varies from 0 to 100: 90-100 means a normal state; the lower the number below 90, the deeper the level of sedation; and 0 represents total suppression of cortical electrical activity. The FDA recommends the use of BIS to monitor the depth of anesthesia during surgery [3]. In recent years, the application of BIS has been more extensive, such as monitoring patients with epilepsy [4], and predicting prognosis of TBI [5-6-8]. In addition, BIS is often used to monitor the sedation level of non-neurological patients [9-11]. Moreover, BIS replaced EEG in several studies on barbiturate coma therapy. And during barbiturate therapy the monitored BIS ranged from 5 to 15 [9-11].

In this case, we combined BIS monitoring, ICP monitoring, long-term mild hypothermia, hypnotic therapy and other means to control refractory ICH successfully, and the patient fully recovered. Setting a target BIS interval and using BIS to monitor the depth of sedation are helpful measures in reducing the incidence of inappropriate sedation, particularly over-sedation. Sedative drugs could reduce agitation and ICP but may also cause adverse reactions such as unstable blood pressure, in which case patients suffering from TBI become vulnerable to a low cerebral perfusion. And this may result in secondary cerebral ischemia, and lead to poor prognosis [1]. Besides, the overuse of a sedative can also lead to severe sedative-related adverse reactions, such as propofol infusion syndrome [12]. In a word, attaining a suitable target BIS interval and using BIS to monitor the depth of sedation are helpful measures in reducing the incidence of inappropriate sedation, particularly over-sedation. Sedative drugs could reduce agitation and ICP but may also cause adverse reactions such as unstable blood pressure, in which case patients suffering from TBI become vulnerable to a low cerebral perfusion. And this may result in secondary cerebral ischemia, and lead to poor prognosis [1]. Bes"


