

Bispectral index decreased to zero for a patient undergoing orthotopic liver transplantation

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A 56-year-old man (height, 165 cm; weight, 75 kg) suspected of having herbal-related fulminant hepatitis was admitted for emergency orthotopic liver transplantation (LT). His medical history was unremarkable, except for hypertension. Upon admission to our hospital, the patient was alert with a Glasgow Coma Scale (GCS) score of 15 (4/5/6) that gradually decreased to 10 (3/2/5) by 28 h after admission. After transfer to the intensive care unit (ICU), intubation was performed and a propofol infusion was started at 4 mg/kg/h. The patient's vital signs were stable, and mechanical ventilatory support was performed with air in O₂ (FiO₂ 0.5). Before surgery, the patient's Model for End-Stage Liver Disease score was 21, and the Child-Pugh score was class C. The patient's pupils were 3 mm/3 mm in diameter (left/right), and brain computed tomography (CT) and magnetic resonance imaging (MRI) revealed no remarkable findings.

Upon arrival to the operating room, the right radial artery was cannulated and arterial blood pressure, electrocardiography, heart rate, pulse oxygen saturation, end-tidal CO₂ concentration, and bispectral index (BIS) were monitored continuously. The preoperative BIS value was 43. Anesthesia was induced and maintained with a 4–6 vol% of desflurane and a 5–15 ng/ml of target effect site-controlled remifentanyl infusion. Mechanical ventilatory support was maintained with air in O₂ (FiO₂ 0.5). A Swan-Ganz catheter was inserted into the right internal jugular vein to monitor cardiac output and pulmonary arterial pressure. Prior to the skin incision, the patient's vital signs were stable, and his BIS value was 14.

Approximately 1 h after the skin incision, the patient's BIS values decreased rapidly to zero. The suppression ratio was 100,

and there was an absence of electric activity on electroencephalography. The patient's pupils remained 3 mm/3 mm (left/right) in diameter. His vital signs were stable, and his body temperature was 35.2°C. The BIS sensors were checked for proper placement. An arterial blood gas analysis was performed to evaluate for metabolic disturbances, but the results did not show any abnormal findings.

During surgery, the patient's vital signs were generally stable (Table 1). We tried to maintain the mean arterial pressure at > 60 mmHg and body temperature at 34–35°C. Despite efforts to increase the BIS level, the patient's BIS values remained at zero until the end of the surgery for a total duration of 10 h 50 min. The surgical procedures were completed uneventfully with a total anesthetic time of 13 h 10 min.

The patient was transferred to the ICU with the endotracheal tube still in place. The patient was sedated using a propofol infusion. After 24 h, the propofol infusion was discontinued, and the patient awoke with a GCS score of (4/E/5) and pupil size of 3 mm/3 mm (left/right). Afterwards, the sedation agent was switched to fentanyl. After being sedated for 52 h, the patient had awakened with an alert mental status of GCS score of 15 (4/5/6) and no neurologic deficits. Brain CT and MRI scans 3 days after surgery revealed no interval changes. Adequate spontaneous respiration was maintained, and the possibility of brain death was excluded. Extubation was performed on the fourth postoperative day after the patient could communicate. Liver function after transplantation recovered sequentially, and the patient was discharged without any complications.

The presence of a BIS value of zero during surgery is a sign

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Table 1. Patient Characteristics according to Liver Transplantation Stage

	Preanhepatic phase	Anhepatic phase	Neohepatic phase
Anesthetic time (h)	7	1	5.2
Total fluid (ml)	12000	4000	14000
Urine output (ml)	115	0	1150
MAP (mmHg)	70 (56–93)	63 (56–63)	70 (50–93)
Heart rate (/min)	90 (85–110)	92 (80–105)	93 (90–105)
Body temperature (°C)	35.4 (35.2–35.8)	34.4 (34–35)	34.8 (34–36)
Cardiac index (L/min/m ²)	3.2 (2.8–3.4)	3.2 (3.0–3.5)	4.2 (3.1–5.0)
pRBC (unit)	9	3	10
FFP (unit)	9	3	10
Platelet (unit)			20

Data expressed as median (range). MAP: mean arterial pressure, pRBC: packed red blood cells, FFP: fresh frozen plasma.

of a poor neurologic prognosis [1]. This case, however, indicates that a BIS value of zero for 10 h 50 min during surgery may not necessarily be correlated with a bad neurological outcome or brain death. The deterioration of consciousness is the most critical complication of fulminant hepatic failure. Therefore, an emergency LT should be performed before irreversible brain damage occurs. Despite active monitoring of brain function in patients undergoing urgent LT, some still suffer brain damage [2]. Therefore, it is important to evaluate a patient's exact brain function status, especially in those with fulminant hepatitis who are already in an unconscious state prior to emergent LT. Brain CT, direct measurement of intracranial pressure, transcranial Doppler imaging, and jugular venous oximetry, can help evaluate cerebral function before surgery [3]. In addition, electroencephalography is the standard method to determine brain function in unconscious patients. One study stated that BIS monitoring may be a useful measurement tool for grading and monitoring the status of hepatic encephalopathy in patients with overt hepatic encephalopathy [4]. Authors reported that mean BIS value decreased in awake patients with chronic liver disease who had more serious conditions (45.4 ± 5.0) than those with mild conditions (90.2 ± 2.5) [4].

A BIS value of zero may be due to inadequate anesthesia,

hemodynamic instability, hypothermia, insufficient muscle relaxation, artifacts by other people or electric devices, and any major metabolic disturbance. Cerebral hypoperfusion can lead to an acute BIS reduction. However, in our case, hemodynamic variables, including arterial blood pressure and cardiac output, were stable. In addition, we repeatedly rechecked the BIS sensor positioning during the operation and kept the patient's body temperature at 34–35°C. Given the patient's condition, a relative anesthetic agent overdose cannot completely be excluded. Changes in drug sensitivity of the central nervous system, protein binding, volumes of distribution, drug metabolism, and drug elimination are more common in patients with liver disease [5]. Therefore, an overdose even with the ordinary use of anesthetics may occur in patients with severe liver disease. Fortunately, our patient recovered normally from anesthesia and showed no neurologic deficits after 52 h postoperatively.

This case has a limitation. We did not monitor BIS during ICU care before and after a BIS value of zero was observed. If we had monitored BIS in the ICU, an in-depth discussion could lead us to a reasonable assumption.

We suggest that a BIS value of zero during surgery is not always correlated with postoperative poor neurological outcome.

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