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Case Report

Transient decreases in Bispectral Index without associated changes in the level of consciousness during photic stimulation in an epileptic patient

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This case report describes a patient with a history of epileptic seizures who showed unusual decreases in the Bispectral Index (BIS) attributable to the induction of abnormal slow electroencephalographic (EEG) waves by photic stimulation, without any associated decrease in his level of consciousness. After starting anticonvulsive therapy, photic stimulation no longer induced abnormal EEG activity nor decreased BIS values. These findings suggest that BIS values may not accurately reflect a patient's actual level of consciousness in the presence of epilepsy-related abnormal EEG activity and that the BIS monitor may be able to track such EEG changes.

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The electroencephalographic (EEG) Bispectral Index (BIS) is used as an indicator of the level of consciousness during anaesthesia.[1 2] Although BIS values are reported to change abruptly upon the appearance of epileptiform EEG activity during general anaesthesia,[3 4] it remains unknown whether such changes in the BIS reflect actual changes in the level of consciousness. We present a patient with epilepsy whose BIS values decreased because of abnormal EEG activity induced by photic stimulation, without any associated decrease in his level of consciousness.

Case report

A 30-yr-old male treated with oral risperidone (6 mg day^{-1}) for schizophrenia developed generalized epileptic seizures. Extensive physical and radiological examinations failed to identify the source of his seizures.

Before starting anticonvulsive therapy, two EEG studies incorporating photic stimulation were performed, the first with a standard EEG monitor using the 10-20 international electrode placement system (10-20EEG) (Synafit1000, NEC, Tokyo, Japan), and the second with both the 10-20EEG monitor and the BIS EEG monitor (A-2000, Aspect Medical Systems, Natick, MA, USA). The BIS electrodes (BIS sensor plus, Aspect Medical Systems) were placed on the forehead and temple according to the manufacturer's recommendation. The smoothing rate for BIS reports was set at 30 s. Standard intermittent photic stimulation was conducted with a flicker device (PS lamp house unit, NEC, Tokyo, Japan) using a white light placed at a distance of 30 cm from the eye while the awake patient was lying on his back with his eyes closed lightly.[5 6] The patient received 10 cycles of 10 s photic stimulation spaced at 10 s intervals. The flicker frequency was set to 1 Hz for the first cycle, increased to 4 Hz for the second cycle and then increased by 2-Hz increments for succeeding cycles to 20 Hz for the 10th cycle.

In both studies, photic stimulation induced the same changes in raw EEG waves. Before photic stimulation, baseline 10-20EEG showed dominant fast low-amplitude waves (8–9 Hz 30–40 μV α waves) and intermittent slow high-voltage waves (3–4 Hz 50–100 μV δ or θ waves) (Fig. 1A). During photic stimulation, frequent slow high-voltage waves 2–4 s

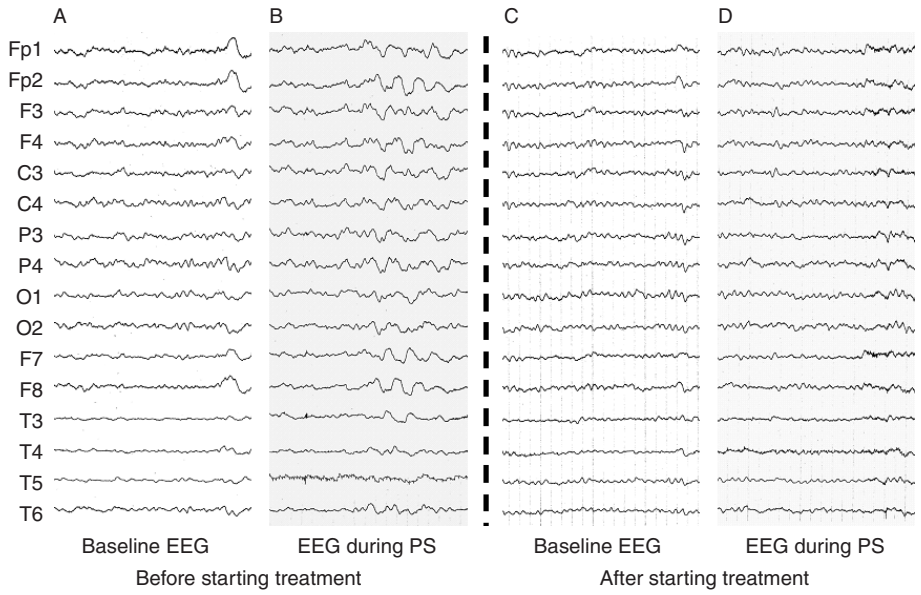

Fig 1 Raw electroencephalogram (EEG) waves recorded by a standard 10-20 system EEG monitor at baseline (A) and during photic stimulation (PS) (B) before starting anticonvulsive treatment with valproate, and at baseline (C) and during photic stimulation (D) after starting the treatment.

in duration were seen, predominantly in frontal areas, while the patient continued to reply promptly to voice without showing any convulsive movements (Fig. 1B). These slow waves disappeared almost completely after photic stimulation ended.

Raw EEG waves displayed on the BIS monitor had a similar appearance to the above-described waves. Before photic stimulation, BIS values ranged between 90 and 98 (Fig. 2D), probably reflecting dominant fast waves intermingled with slow high-voltage waves (Fig. 2A). Forty-five seconds after starting photic stimulation, BIS values decreased rapidly to a minimum of 63 (Fig. 2E), probably reflecting dominance of the slow high-voltage waves (Fig. 2B). After photic stimulation ended, BIS values returned to baseline levels over the next 30 s (Fig. 2E). During the period of intermittent photic stimulation, the patient replied promptly to voice every 10 s. After the EEG examination ended, he had an explicit memory of the flickering light, seen through the closed eyelids, throughout the photic stimulation period over 190 s.

Subsequently, an oral anticonvulsant, sodium valproate, 800 mg day^{-1} was added to the patient's schizophrenia treatment regimen. Two weeks later, when the plasma valproate concentration had reached a therapeutic value (78.9 $\mu g\ ml^{-1}$), we conducted a third EEG study using both BIS and 10-20EEG monitors. The baseline EEG was almost identical to the baseline EEGs of the earlier studies, except that fewer slow high-voltage waves were present (Fig. 1C). BIS values ranged between 94 and 98 (Fig. 2F). Photic stimulation only minimally increased the number of slow high-voltage waves (Figs 1D and 2C) and minimally decreased BIS values (92 at a minimum) (Fig. 2F). A follow-up EEG conducted 6 months later, with the patient still treated with valporate, detected no baseline or photic stimulation-induced abnormalities in raw EEG waves or BIS values.

Discussion

Untreated epileptic patients are reported to exhibit significant slowing of background EEG with increased δ and θ power, which is reduced with treatment with valproate.[7,8] In the present case, slow EEG waves in the δ or θ band were occasionally seen even during wakefulness before institution of anticonvulsive therapy. Bispectral analysis and power spectral analyses are major components of the BIS algorithm,[2,9] and therefore the appearance of δ or θ waves during wakefulness might have resulted in a slight decrease in baseline BIS values (90–98) initially seen in the present case. During photic stimulation, BIS values decreased further to a minimum of 63, probably reflecting a photic stimulation-induced predominance of slow δ or θ activity, although the patient remained quite alert to our calls during the examination, and afterwards, he had a thorough memory of the examination. This case suggests that BIS values may not accurately reflect the actual level of consciousness when abnormal EEG activity is evoked in epileptic patients.

The search for a reliable depth of anaesthesia monitor is ongoing. The BIS algorithm is not fully known, and high BIS values associated with low level of consciousness and low BIS values associated with intraoperative awareness have been reported.[9] The present case report describes a false low BIS reading in an epileptic patient during photic stimulation, once again showing that this depth of anaesthesia monitor has some limitations. It is quite conceivable, however, that BIS values do not always reflect the actual