

# Changes in Density Spectral Array of BIS VISTA Monitoring System in Epilepsy Surgery

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## Abstract

We report the case of a patient with drug resistant epilepsy scheduled for amygdalohippocampectomy (AHS). During this type of surgery, Density Spectral Array (DSA) belonging to the Bilateral Bispectral Index (BIS) VISTA™ Monitoring System (BVMS) was used. DSA, but no BIS trend, was helpful to detect differences in the power spectrum between both cerebral hemispheres during propofol-remifentanyl-dexmedetomidine anesthesia. This case provides novel evidence to support the clinical utility of DSA in monitoring depth of anaesthesia and sedation.

**Keywords:** Epilepsy; Density spectral array; BIS VISTA

## Introduction

Anaesthesiologists use sedative drugs, opioids, hypnotics and neuromuscular blocking agents to induce and maintain general anaesthesia, monitoring cardiovascular, respiratory and EEG parameters all along the procedure. EEG monitoring used in clinical practice offers information about the state of consciousness. The Bispectral index (BIS) VISTA™ Monitoring System (BVMS) (Aspect Medical Systems INC, Norwood, MA) consists of the BIS VISTA Monitor, the BIS x 4, the PIC-4 and a BIS Bilateral Sensor. The single-use sensor uses an electrode montage designed to capture high-quality EEG signals from both of the patient's cerebral hemispheres. The BVMS was designed to allow the user to record and display four channels of EEG; two from each side of the brain. This monitor equally shows changes in the power spectrum distribution through the Density Spectral Array (DSA). Asymmetry (ASYM) is a processed variable indicating the percentage of EEG power present in left or right hemispheres with respect to total (left and right) EEG power [1]. Asymmetry graphical data may be plotted as part of the DSA display. The ASYM scale begins at 20% at the centre line and runs left or right to 100%. In a situation of clear hemispheric difference, the Asymmetry Indicator points to the hemisphere that measures greater power. The DSA also shows the SEF 95, the frequency at which 95% of the total power lies below it.

In our case BVMS was used to observe changes in DSA, during the anesthetic-surgical procedure. This case report evidences the potential value of this monitor.

## Case Report

A 57-years-old woman, Glasgow Coma Score 15, ASA grade II, with drug resistant epilepsy since she was 19 years, was scheduled for resection of epileptogenic focus by intraoperative electrocardiography (ECoG). She evidenced epileptic crisis with semiology of focal seizure, alteration of the level of conscience, and ictal language, with a frequency of 8 per month. These symptoms were facilitated during periods of stress and they were prevalent at night. She was administered Carbamazepine, with deficient control of crisis, Phenobarbital (10 mg/12h), Lacosamide (200 mg in the morning and 300 mg in the afternoon), Pregabalin (300 mg/12h). The patient submitted written consent for the procedure and the use of dexmedetomidine.

She entered the epilepsy unit to be evaluated before surgery. During her stay in the unit, nine epileptic seizures were registered, all of them originating in the right anterior temporal lobe. The surgeons decided to perform a right amygdalohippocampectomy (AHS) by subtemporal approach with intraoperative ECoG on hippocampus.

On entering the operating room, the electrocardiogram, non invasive blood pressure and the percentage oxygen saturation were monitored. BVMS electrode strip was placed on the front temporal position according to the International 10-20 system of electrode placement, and a BIS Vista was used to record BIS values. Anaesthesia was induced with midazolam (1.5 mg iv), a dexmedetomidine infusion (0.3 mcg/kg/h), fentanyl (300 mcg), propofol (110 mg), and rocuronium (40 mg) to facilitate endotracheal intubation. A radial artery and a right internal jugular vein were selected for monitoring the invasive blood pressure and the central venous pressure respectively. Anaesthesia was maintained with infusions of propofol (2.11 mg/kg/h), remifentanyl (0.06 mcg/kg/min), and dexmedetomidine (0.3 mcg/kg/min) to keep BIS values within 45-60 range. Rocuronium was also administered (0.3 mg/kg/h). Cardiovascular parameters remained stable during the procedure. A simultaneous EEG was monitored to document functional changes in the ipsi- and contralateral hemisphere.

At the beginning of the procedure, DSA displayed a SEF 95 higher than 20 Hz; the anesthetic induction drastically decreased this value, while the alpha band appeared (Figure 1A).

During surgery, an asymmetry was detected related to the right hemisphere, where the epileptogenic focus was (Figure 1C). This asymmetry was a consequence of a power increase in low frequency (0.1-4 Hz) and alpha bands (8-12 Hz). Before performing the intraoperative ECoG, propofol and remifentanyl infusion rates were slowed, which caused a decrease of power in low frequency and alpha bands, more visible in the left side (Figure 1B). This procedure, resulting in light anaesthesia, boluses of propofol had to be administered leading to a power increase in the right side frequencies (Figure 1c). Unlike DSA, the BIS trend did not reflect differences between two hemispheres.

The ECoG was successful and the surgeons were able to remove the epileptogenic focus. The patient was extubated in the operating

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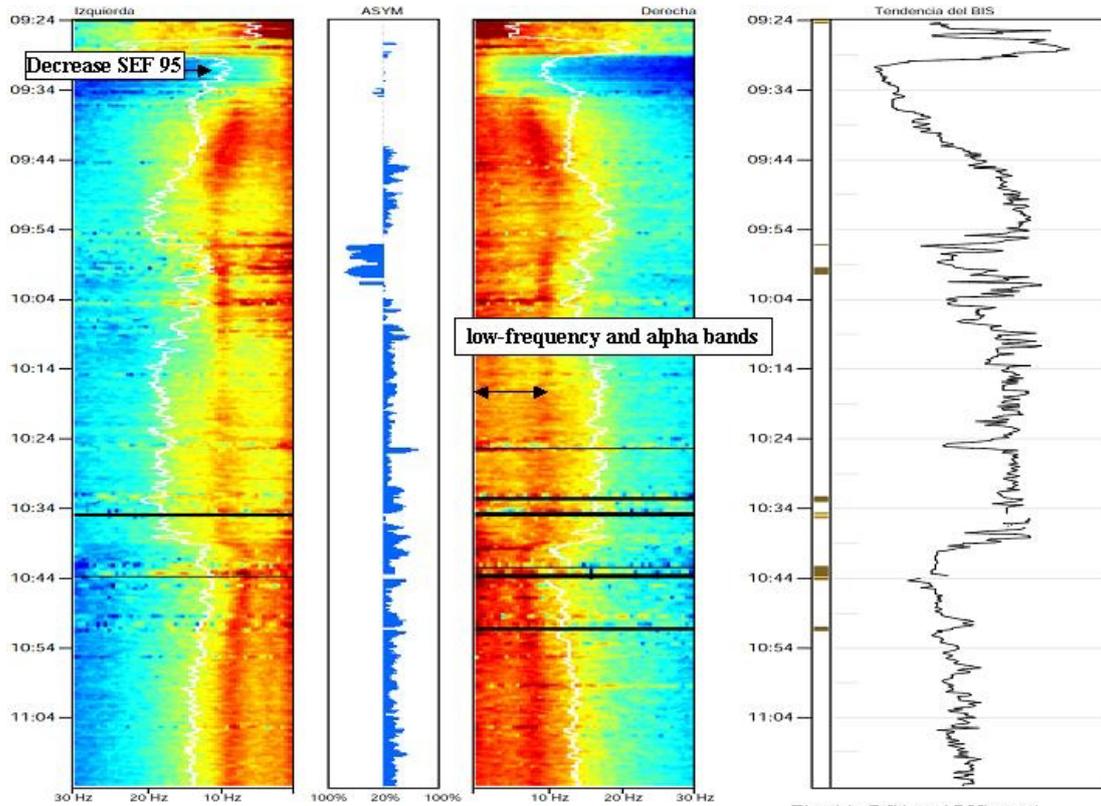


Fig. 1A. DSA and BIS trend

Figure 1a: Density Spectral Array (DSA) and Bispectral index trend (BIS). Presence of intense alpha waves and low-frequency power more clear in the right side.

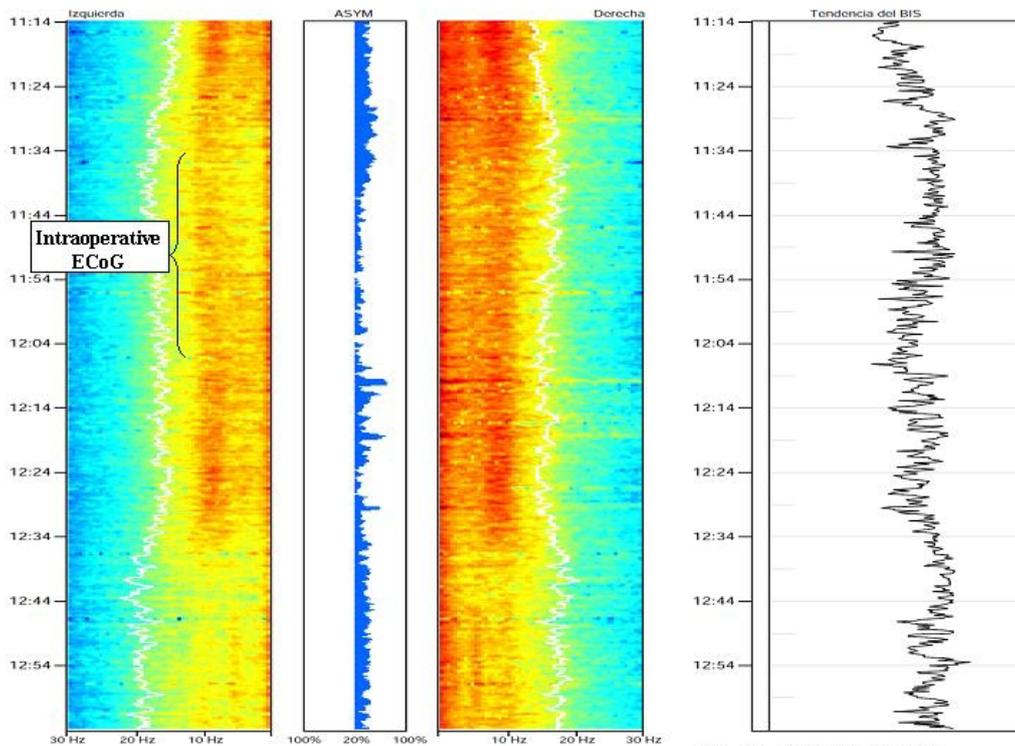


Fig. 1B. Intraoperative ECoG

Figure 1b: Intraoperative electrocorticography (ECoG) with reduction of propofol and remifentanyl perfusion and the presence of gamma and beta power.

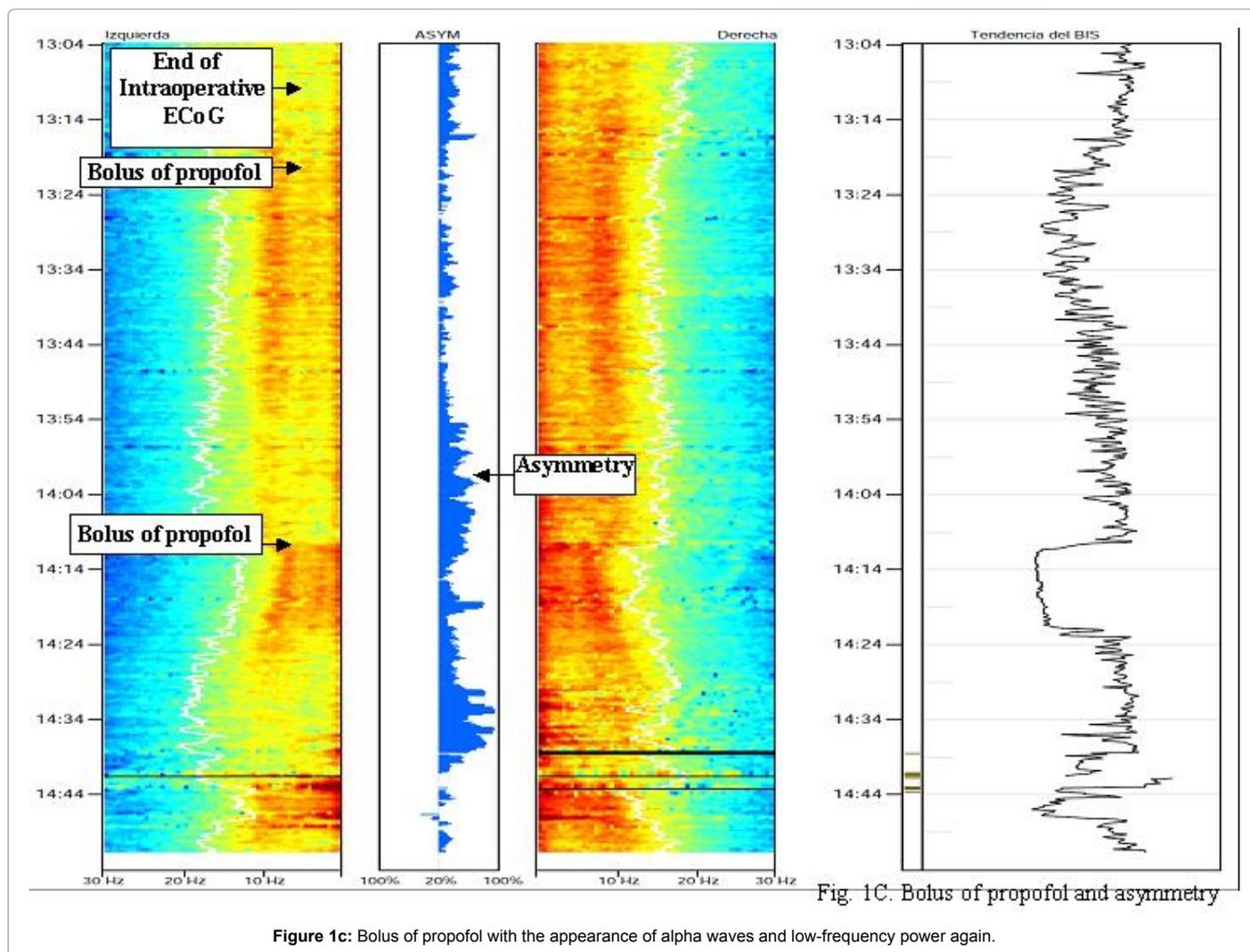


Figure 1c: Bolus of propofol with the appearance of alpha waves and low-frequency power again.

room and transferred to the recovery room. She was discharged from hospital five days later.

## Discussion

Density spectral array (DSA) applies fast-Fourier transformation (FFT) to convert raw EEG into a time-compressed and color-coded display, also termed a color spectrogram [2-4]. Clinical applications of DSA and related techniques have included monitoring depth of sedation [5], detecting cerebral ischemia [6], and identifying seizures in adults, children, and neonates [7-9].

During propofol, remifentanyl, dexmedetomidine anaesthesia, bilateral monitoring of DSA allowed us to detect differences in the power spectrum between both hemispheres. DSA evidenced higher alpha power in the affected side (right), suggesting greater sensitivity of this hemisphere to drugs. These differences were also seen by operating changes in propofol dose. The usefulness of DSA has been criticized due to the high variability among patients, and because a single descriptor is not enough to measure the anesthetic depth [10].

Our case reveals that a complex algorithm such as BIS trend, failed to detect differences between both hemispheres, while DSA was able to do it. Artifacts from manipulations in the area near the sensor, could explain the lack of correlation between DSA and BIS trend, however

these events would have been recorded in the DSA, yet this did not occur [11].

Muscular activity could not have been the cause either as the patient received a continuous rocuronium infusion during surgery [12]. On the other hand, during the anesthetic procedure a component of the phenomenon known as anteriorization was identified, along with an increase of low frequency power in frontal position alpha bands as the depth of anaesthesia were also increased [13]. Purdon et al. stated that 30 minutes prior to LOC (loss of consciousness), gamma (25–40 Hz) and beta (13–24 Hz) power increased significantly above baseline levels and remained elevated during the unconscious period. In LOC, both alpha (8–12 Hz) and low-frequency (0.1–1 Hz) power increased significantly. Fifteen minutes after LOC, the increases in alpha power were concentrated in frontal channels, whereas those for low-frequency power were distributed broadly across temporal and parietal channels. During emergence, these changes in power occurred in reverse, following a similar time course: frontal alpha and low frequency power decreased at recovery of consciousness (ROC), whereas gamma/beta power remained elevated throughout the post-ROC period [14].

DSA is a significant tool in monitoring brain state in neurosurgical patients, the access to this parameter being valued since it is easier for the anaesthesiologist to understand and interpret than raw EEG.

Nevertheless, such limitations of the system as the absence of information from areas further from the electrodes (that condition their lack of usefulness in patients with focal parieto-occipital disorders) must not be overlooked. This case provides novel evidence to support the clinical utility of DSA in monitoring depth of anaesthesia and sedation.

#### Acknowledgments

The patient of this case report has submitted her written consent.

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