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Παρουσίαση Περιστατικού – Case Report

Intraoperative burst suppression on electroencephalographic density spectral array of bispectral monitoring immediately after tourniquet release

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ABSTRACT

Intraoperative burst suppression on electroencephalographic density spectral array of bispectral monitoring immediately after tourniquet release.

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Depth of anesthesia is a dynamic balance between effect-site concentration of hypnotic and analgesic drugs, and intensity of surgical stimulation. The bispectral monitor is the best described monitor of the depth of hypnosis component of anesthesia. Yet, interpratation of the displayed data may be challenging. We hereby present a case of intraoperative burst suppression on electroencephalographic density spectral array of bispectral monitoring caused by tourniquet deflation.

Keywords: Bispectral index, Electroencephalography, Anesthesia, Tourniquet

INTRODUCTION

The bispectral monitor (BIS) is a frontal electroencephalography (EEG)-derived processed index, which is widely used for the monitoring the depth of anesthesia. Apart from the BIS value, it also can provide a series of other parameters, such as suppression ration or the electroencephalographic density spectral array (DSA), than facilitate interpretation and definition of the state of "hypnosis" at any given moment. The present report describes a case of a burst suppression caused by tourniquet deflation in young male patient undergoing orthopaedic surgery under general anesthesia.

CASE REPORT

A 17-year-old male [body weight (BW): 73kg, height: 189cm], was referred from our sport

injury clinic, for an anterior cruciate ligament tear reconstruction surgery. Past medical history and preanesthetic assessment were unremarkable (ASA classification: I, METs score: 10).

Pre-induction baseline vital signs were: heart rate (HR): 95 bpm, blood pressure (BP): 120/70 mmHg, SpO_2: 99%. General anesthesia was selected as preferred anesthetic technique by the patient. Preoperatively ondasetron 4mg iv, omeprazole 40 mg, amikacin 500mg iv and Ampicillin/sulbactam 3gr were given. On anesthesia induction Fentanyl 3.5 μg/kg iv, Lidocaine 1.4 mg/kg mg iv, Propofol 2.2 mg/kg iv and Rocuronium bromide 1 mg/kg iv were administered, while Desflurane 1.1 MAC was used for anesthesia maintenance (BIS value range: 35-46). Mechanical ventilation parameters were: CMV mode: Vt 7.2 ml/kg, RR 12 bpm, PEEP 5 cmH_2O, Ti:Te 1:2.1 , FiO_2 35%. Before tourniquet placement further Dexamethasone 8 mg iv, Parecoxib 40mg iv, Paracetamol 1 gr iv were given. Pneumatic tourniquet inflation (300 mmHg) transiently elevated vital signs by 10%; otherwise, they remained on average 10 -15% below baseline. A remifentanil infusion was also started (8μγ/ml solution at about 0.03 μγ/kg/min civ). Tourniquet inflation remained for 1 hour 44 minutes. About 35 min before tourniquet deflation additional fluid (Plasmalyte® 1000ml) and fentanyl 2 μ/kg iv were administered. Immediately after its deflation, haemodynamic state remained stable; yet an elevation of $etCO_2$ from 36 to 45 mmHg with a concomitant burst suppression on density spectral array (DSA) of BIS monitoring (BIS® Medtronic, MN, USA) was noticed. During this phenomenon only delta waves were detected in high frequencies, with theta waves following in moderate to high frequencies. Both spectral edge and median power frequencies dropped below 4Hz from a previous 15Hz and 7Hz respectively.BIS value decreased momentarily down to 17. Mechanical ventilation settings were modified to accomplish decrease of $etCO_2$. The EEG of the patient returned to his pre-deflation baseline values after 3.5 minutes (Image 1), while the $etCO_2$ returned to pre-deflation baleline values within 8-10 minutes.

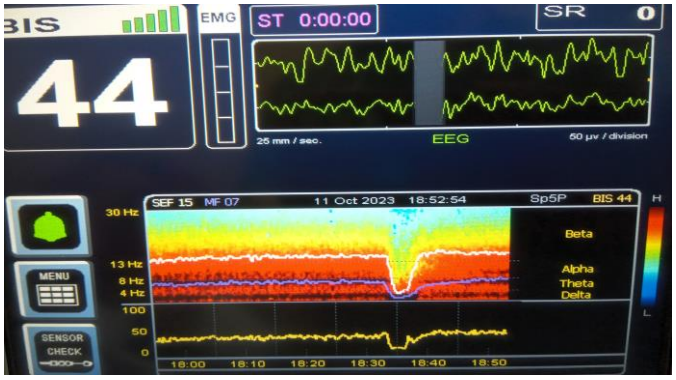

Image 1. Photo of DSA BIS moniroing (2-channel monitor), displaying the moment of burst suppression (arrow).

Morphine 0.05mg/kg iv, 30 minutes before emergence, for postoperative analgesia. Emergence from anesthesia was uneventfull and the patient was transferred to ward after 15 minutes of stay in postoperative recovery unit.

DISCUSSION

EEG-derived information monitoring systems are becoming more and more common in general anesthesia. Most of them aiming at measuring the hypnotic component of anesthesia; yet there are also systems that aim analgesic component (Table 1)[1]. BIS collects raw EEG data through its sensors and uses an algorithm that removes noise and artifacts from a variety of sources (eg, electrocardiography, electromyography from facial muscular activities, peripheral nerve stimulators, electrocautery, etc.), it then combines the several parameters to generate a single dimensionless BIS value. (Table 2)[2].

Hypnotic component EEG systems	Analgesic monitoring EEG systems
Patient State Index (PSI™; Sedline, Masimo, Irvine, CA	Brain Anaesthesia Response monitor (BAR; Cortical Dynamics Ltd, North Perth, Australia)
Bispectral index (BIS; Medtronic, Dublin, Ireland),	Composite variability index (CVI) from the bispectral index (Medtronic)
State and response entropy (SE/RE; GE Healthcare, Helsinki, Finland)	qNOX (Qantium Medical, Barcelona, Spain)

Table 1. Examples of commercially available intraoperativc EEG monitoring systems.

Parameter	Domain type	Description
Burst suppression ratio	Time	Period of “fully supressed” EEG
QUAZI suppression	Time	Period of “nearly supressed” EEG
Relative β ratio	Frequency	Degree of high-frequency activation
SynchFastLow	Frequency (bispectral)	Low frequency synchonisation

Table 2. Parameters affecting BIS value

DSA applies fast-Fourier transformation to convert raw EEG into a time-compressed and color-coded display, also termed a color spectrogram, is only one of the additional data reported on data monitor.bOther data displayed are EMG (electromyogram, in Hz units, measures muscle activity), SQI (signal quality index, quality of EEG signal with 100% representing perfect signal quality and 0% poor signal quality), SR (suppression ratio,

proportion in % of a 63 sec period during EEG activity was supressed), TP (total power, summation of power of the various component waves) and SEF95 (frequency below which 95% of the total EEG power lies)[2].

Abrupt BIS value decrease can be caused by sudden decrease in noxious stimulation, bolus administration of anesthetics or muscle relaxants or changes in physiological state such as profound hypotention, hypothermia, anoxia, or hypoglycaemia[3].

Tourniquets though widely and safely used in many orthopedic surgeries, alter normal physiology. Especially, at the moment of deflation-when anaerobic metabolites enter systemic circulation-both local (nerve injury, muscle injury) and systemic complication can be observed. The latter vary from transient hypotention to myonephropathic metabolic syndrome or even rarer cardiac arrest[4]. All these depend on the size of the extremity, duration of tourniquet time, and overall physiologic status of the patient.

In our case no hemodynamic changes were noticed. Thought tourniquet pain abrupt decrease by deflation may had also to decreased BIS value, is also a remote scenario. Despite the absence of objective pain monitoring, such as nociceptive level (NOL®, Medasense Biometrics Ltd., Ramat Gan, Israel) monitoring analgesic monitor, and the fact that tourniquet pain is more common under general anesthesia (53–67%) and occurs most often during lower-limb surgeries[3], we suggest that additional analgesia – along with remifentanil infusion- before deflation was sufficient enough to prevent a change like the one noticed.

Therefore, we hypothesise that an increase in cerebral blood flow secondary to increased et CO_2 caused an abrupt uptake of inhalational anesthetic that caused the transient change both in BIS values and in DSA BIS record.

Literature reports notice that at the sub-MAC concentrations, the spectrogram of desflurane resembles propofol with very low theta oscillation power. When the concentration of desflurane is increased to MAC levels and above, a theta oscillation fills in between the delta and alpha bands[5]. Early literature reports also noticed a burst suppression under desflurane anesthesia in doses over 1.24 MAC[6]. Predeflation light hypocapnia in our case may have been a mean of avoiding abrupt increase of etCO_2, yet this is not a common practice that is followed. Newer technologies, such as silicone ring tourniquets, are promising alternatives with lower incidence of complications[7].

CONCLUSION

Despite the wide and safe use of arterial tourniquets in daily practice, we should not forget that they can have significant systemic as well as local effects on the body. Thus, it’s important to be alerted to manage early any possible complication.

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