Case Report

Bilateral bispectral index monitoring to detect cerebral hypoperfusion during carotid endarterectomy under general anesthesia

ABSTRACT

The bilateral use of bispectral index (BIS) monitoring in a 68-year-old male who underwent right carotid endarterectomy (CEA) under general anesthesia (GA) is described. During three episodes of right internal carotid artery cross-clamping intraoperatively, the right BIS value rose relative to the left within 1 min of clamping, followed by a return to baseline within 1–2 min of clamp release. Since unilateral BIS values can decrease or increase in response to cross-clamping, a significant difference in left and right BIS values may provide a simple and easily available method to detect cerebral hypoperfusion during CEA under GA.

Key words: Bispectral index; carotid endarterectomy; general anesthesia

Introduction

Carotid endarterectomy (CEA) is an established treatment for extracranial internal carotid artery (ICA) stenosis. However, there is a risk of neurological damage from cerebral hypoperfusion that can occur after ICA cross-clamping during CEA. Neurological monitors used to detect this under general anesthesia (GA) include transcranial Doppler, electroencephalography (EEG), near infrared spectroscopy, somatosensory evoked potentials, and jugular venous oxygen saturation, some of which are complicated to use and not widely available. In contrast, bispectral index (BIS) is a processed EEG parameter that is simple to interpret and already commonly employed in many operating theaters today. The bilateral use of BIS to detect cerebral hypoperfusion during CEA under GA is described. Written consent was obtained from the patient for the publication of this case report.

Case Report

A 68-year-old male with a history of hypertension and hyperlipidemia presented with a transient ischemic attack with right amaurosis fugax. Ultrasound Doppler of the carotid vessels revealed ICA stenoses of 73% on the right and 67% on the left. Computed tomography angiography of the circle of Willis showed diffuse atherosclerotic changes with no flow-limiting stenosis. In view of the symptomatic right ICA stenosis, a right ICA endarterectomy with intraoperative shunt and xenograft patch repair under GA was planned.

Access this article online	
Website: www.saudija.org	Quick Response Code
DOI: 10.4103/sja.SJA_347_17	

How to cite this article: Zheng JX. Bilateral bispectral index monitoring to detect cerebral hypoperfusion during carotid endarterectomy under general anesthesia. Saudi J Anaesth 2018;12:125-7.

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Before induction of anesthesia, separate BIS Quatro™ (Aspect Medical Systems, Inc., Norwood, MA, USA) sensors were applied to each side of the patient's forehead according to the manufacturer's specifications, providing continuous, simultaneous left- and right-sided readings on two BIS VISTA™ (Aspect Medical Systems, Inc., Norwood, MA, USA) monitors throughout surgery. Starting BIS values were 95 on both sides. Anesthetic induction and endotracheal intubation were performed, with maintenance of total intravenous anesthesia using propofol, remifentanil, and atracurium.

From 30 min before cross-clamping of the right ICA till the end of surgery, the patient was maintained on constant target controlled infusion rates of intravenous propofol at 3 mcg/ml and remifentanil at 1 ng/ml. From the time of anesthetic induction to cross-clamping, left and right BIS values correlated well and were maintained between 30 and 45.

Upon right ICA cross-clamping, the right BIS value rose from 45 to 60 within 1 min. A Pruitt-Inahara shunt was inserted within 4 min and right carotid bypass initiated, followed by a decrease in BIS to 44 after <2 min. Left BIS value remained stable at 41 during this period, with stable anesthetic infusion rates. There were two subsequent episodes of the right ICA cross-clamping. The right BIS increased from 45 to 77 over 4 min during clamping for shunt removal and from 55 to 72 over 3 min during clamping for hemostasis. In both instances, the right BIS returned to baseline within 1–2 min of clamp release, with left BIS stable at 41–45 [Figure 1]. The patient did not suffer any intraoperative awareness or postoperative neurological complications from the 4 h procedure.

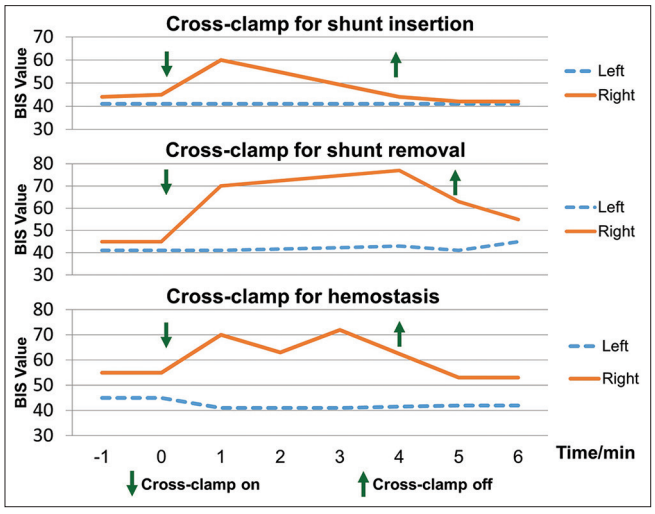

Figure 1: Evolution of bilateral bispectral index values for the three separate episodes of the right internal carotid artery cross-clamping

Discussion

EEG is a well-accepted modality for detecting cerebral hypoperfusion during CEA under GA and can be used to help determine the need for shunting[1] when clinical neurological surveillance is not possible. However, it is not readily available in the operating theater environment, and its interpretation is complex, requiring the presence of specialized personnel. BIS is based on processed EEG parameters and uses a proprietary algorithm to derive a single-integer value that is easy to understand. Together with its ease of use and ubiquitousness in today's operating theaters, BIS can serve as a relatively inexpensive option for detecting cerebral hypoperfusion during CEA.

Although BIS was initially designed to indicate the depth of anesthesia, BIS values have also been reported to drop during severe intraoperative hypotension and can therefore be used to indicate significant changes in cerebral blood flow. During CEA, BIS has been shown to decrease when cerebral ischemia occurs upon ICA cross-clamping[2,3] and increase after a shunt is placed to augment cerebral blood flow.[4,5] However, there are cases where this does not occur reliably. Deogaonkar *et al*.[6] continuously monitored 52 patients undergoing awake CEA with only ipsilateral BIS together with assessment of neurological function and did not find a correlation between unilateral BIS values and neurological assessment in patients who developed clinically apparent neurological deficits during the clamping period. In a study by Bonhomme *et al*.[7] on 36 patients undergoing CEA under GA, unilateral BIS was also monitored and was noted to increase over 60 in 47%, decrease below 40 in 25%, and remain in the 40–60 range in 28% of all patients after cross-clamping. The unexpected BIS increase was suggested to result from altered neuronal firing and excitability due to borderline ischemia, a decrease in brain anesthetic agents concentration because of changes in cerebral blood flow induced by carotid clamping, or a change in the nociceptive-antinociceptive balance associated with the painful stimulation of cross-clamping. These can explain the paradoxical increase in BIS values also seen in this case report.

Unilateral BIS monitoring during CEA has been reported, and its interpretation has been shown to be difficult, given the inconsistency in the direction of ipsilateral BIS changes during cross-clamping, and the fact that BIS can also vary with anesthetic agent delivery, surgical stimulation, hemodynamics, and temperature. These limitations of unilateral BIS monitoring may be overcome by the bilateral application of BIS instead, aiming to detect a difference in left and right BIS values after ICA cross-clamping which can indicate a clinically significant reduction in ipsilateral

cerebral blood flow. To date, there are no large studies evaluating the bilateral use of BIS in this situation. This case report suggests that bilateral BIS monitoring during CEA under GA can provide a simple, noninvasive, and easily available method to detect cerebral hypoperfusion that can trigger the decision to insert a shunt. Further studies, however, will be required to investigate this further and determine the difference in bilateral BIS values that can be considered to be significant.

Conclusion

Neurological damage from cerebral hypoperfusion is a known complication of ICA cross-clamping during CEA. Bilateral BIS monitoring to detect a difference in left and right BIS values may provide a simple and convenient means of detecting such a reduction in ipsilateral cerebral blood flow when the procedure is performed under GA.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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