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CASE REPORT

Bispectral index detects intraoperative cerebral ischaemia during balloon assisted cerebral aneurysm coiling [version 1; peer review: 3 approved with reservations]

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Abstract

Bispectral index (BIS) is a monitoring modality designed and used for monitoring depth of anaesthesia. We wish to report a case where BIS monitoring may have alerted us to a potential adverse neurological event during angiographic coiling of a cerebral aneurysm.

Open Peer Review

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2. **Luzius A Steiner**, University Hospital Basel, Basel, Switzerland

3. **Mark Coburn**, University Hospital RWTH Aachen, Aachen, Germany

Any reports and responses or comments on the article can be found at the end of the article.

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Competing interests: No competing interests were disclosed.

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Case

Bispectral index (BIS) is a monitoring modality designed and used for monitoring depth of anaesthesia. However, it may also have other advantages in detecting intracranial haemodynamic events¹⁻³. We wish to report a case where BIS monitoring may have alerted us to a potential adverse neurological event during angiographic coiling of a cerebral aneurysm.

A 56 year old, right handed male was listed for coiling of an unruptured intracranial aneurysm. The aneurysm was discovered as an incidental finding on a CT scan of the head performed for the investigation of a previous episode of confusion. Cerebral angiography demonstrated an approximately 12mm wide necked aneurysm at the termination of the intracranial segment of the left internal carotid artery (ICA) (Figure 1). The patient's past medical history included hypertension and heavy smoking and he had a BMI of 32.

A small premedication dose of 2mg intravenous midazolam was given whilst an arterial line was inserted to allow continuous invasive intra-arterial blood pressure monitoring. Standard AAGBI monitoring was supplemented with BIS (Aspect Medical Systems, Newton MA, USA) that was positioned over the forehead and left temporal area before induction. An infusion of TCI (target controlled infusion) remifentanyl was then commenced with an effect site (Cet) of 2ng/ml increasing to 4ng/ml before induction, which consisted of 140mg propofol, with rocuronium 60mg given to facilitate tracheal intubation.

Anaesthesia was maintained with sevoflurane (end tidal concentration 1.2–1.4) and TCI remifentanyl continued at Cet of 4ng/ml, targeting a BIS range of 40–55. A metaraminol infusion was used to maintain a systolic blood pressure between 110–130mmHg. End tidal CO₂ was maintained in the range of 4.5–5.1kPa.

Coiling was performed with vascular access obtained via a right femoral arterial puncture. Using a guide catheter placed in the extra-cranial segment of the left ICA, a balloon catheter was navigated into the intracranial circulation. The inflatable/deflatable 4mm balloon was positioned across the neck of the aneurysm and during inflation there was simultaneous occlusion of the neck of the aneurysm and the proximal segment of the left middle cerebral artery (MCA). The balloon was intermittently inflated across the neck of the aneurysm to prevent coil prolapse during placement of 11 platinum microcoils into the aneurysm. Each inflation lasted in the order of 30–120 seconds. An intravenous bolus of 5000 units of Heparin was given to minimize the risk of thromboembolism associated with the endovascular devices.

The photograph of the intraoperative BIS trend (Figure 2) shows that the first time the balloon was inflated, the BIS value fell to approximately 25 over a 60 second period. Upon balloon deflation, BIS returned more rapidly to its pre-inflation value. The anaesthetic team alerted the neuro-radiologists to these changes. They were able to limit the duration of subsequent balloon inflations resulting in demonstrably shorter subsequent BIS falls.

Figure 1. Cerebral angiography demonstrated a wide necked aneurysm at the termination of the ICA.

Figure 2. Photograph demonstrating repeated falls in BIS value with each balloon inflation, with rapid recovery to pre-inflation value upon deflation.

Post procedure, the patient was woken up and on return to the ward had a GCS of 15 with no neurological deficit. He was discharged home after 48 hours and has recovered well at home with no problems.

Discussion

This case clearly illustrates that intraoperative Bispectral Index (BIS) monitoring may allow the detection of cerebral hypoperfusion. An abrupt decrease in BIS values not associated with changes in anaesthetic technique or haemodynamics may alert the anaesthetist to such an event. Early communication with the surgeon or interventionist can potentially avoid procedure related neurological injury.

There have been previous case reports of sudden decreases in BIS value during other neurosurgical and neuro-radiological interventions. These include rupture of cerebral aneurysms during coiling¹, embolization of arterio-venous malformations² and intraventricular haemorrhage during third ventriculocopy³. Rapid increases in intracranial pressure and vasospasm have been postulated as possible causes for the decrease in BIS values.

The aneurysm in this case was on the ICA at the termination of the vessel. The angiographic balloon was placed via the ICA into the proximal MCA. Balloon inflation with simultaneous occlusion of the distal ICA and proximal middle cerebral arteries is more hazardous than the same procedure confined to the ICA as complete occlusion of the carotid tip prevents collateral flow from the contralateral circulation to the MCA (via the circle of Willis). Repeated balloon inflation within a vessel may lead to platelet aggregation or vessel wall injury with subsequent neurological injury. However, in this case the repeated acute change in the BIS values suggests a haemodynamic, rather than a thromboembolic, insult to the distal circulation.

In this patient, the BIS sensor was positioned to primarily monitor the cerebral hemisphere undergoing intervention. Studies investigating the effects of cerebral ischaemia (such as during carotid endarterectomy) on BIS have been contradictory with some demonstrating a correlation with ischaemia whilst others show none^{4,5}. The advent of a bilateral BIS sensor for general anaesthesia⁶ may shed more light on these discrepancies and allow more subtle ischaemic changes (possibly resulting in left to right BIS differences) to be detected.

Not all balloon assisted neuro-radiological procedures will result in potential ischaemia, however those involving vascular territories with poor collateral circulation might benefit from the use of bilateral BIS as a tool to detect early and potentially avoidable adverse neurological events.

Consent

Written informed consent for publication of their clinical details and clinical images was obtained from the patient.

Author contributions

JA and ZH conceived the idea. SC and RD were the neuro-radiologists involved with the case in question.

ZH prepared the first draft of the manuscript, with all authors contributing to revisions of the draft and all authors have agreed to the final content.

Competing interests

No competing interests were disclosed.

Grant information

The author(s) declared that no grants were involved in supporting this work.

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Version 1

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Mark Coburn

Department of Anesthesiology, University Hospital RWTH Aachen, Aachen, Germany

The conclusions which the authors draw from this case report are far too strong and need to be adapted.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 27 December 2013

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Luzius A Steiner

Department of Anaesthesia, University Hospital Basel, Basel, Switzerland

This is an interesting case report. However, the discussion is somewhat superficial. I have two comments:

1. Please make it clear that the sensitivity to detect cerebral ischemia by EEG is not perfect and that the BIS monitor has not been developed for this purpose. Please explain why you think that an ischemic event would lead to a decrease in the BIS value from approximately 50 to 25 in your case (but not in all cases e.g. your references).
2. What is the temporal relationship between the balloon inflation and the BIS value. You state

that it "fell to approximately 25 over a 60 second period". Theoretically, I would expect some delay before the BIS reacts (already because it samples over 15 or 30 seconds to calculate the BIS value; which sampling interval did you use?). Is there an alternative explanation you could offer (e.g. did you check the EMG value)? Did you administer neuromuscular blockers or other drugs prior to balloon inflation, is it possible that you recorded an artifact of some type? Please expand your case description and the discussion.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 05 November 2013

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Ehab Farag

Department of General Anesthesiology and Outcomes Research, The Cleveland Clinic Foundation, Cleveland, OH, USA

The authors should mention that BIS has a very limited ability to detect ischemia as it only monitors the frontal lobe. Therefore it cannot be compared to traditional 16 channels EEG or NIRS to detect cerebral ischemia. This case should not be used as standard for care for using BIS as a monitor for cerebral ischemia.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response () 13 Nov 2013

John Andrzejowski, Royal Hallamshire Hospital, Sheffield, UK

I agree with Dr Farag's comments. I would be happy to change the discussion to read:

BIS has a limited ability to detect ischemia since, similarly to Near Infra Red Spectroscopy (NIRS), in its usual montage it only monitors a frontal lobe. It cannot be compared to a traditional 16 channel EEG that monitors the whole brain, and should not be considered as a standard of care for detecting cerebral ischaemia.

In this patient, the BIS sensor was positioned to primarily monitor the cerebral hemisphere undergoing intervention.

Studies investigating the effects of cerebral ischaemia (such as during carotid endarterectomy) on BIS have been contradictory with some demonstrating a correlation with ischaemia whilst others show none^{4,5}. The advent of a bilateral BIS sensor for general anaesthesia⁶ may shed more light on these discrepancies and allow more subtle ischaemic changes (possibly resulting in left to right BIS differences) to be detected.

Competing Interests: one of the authors of the article

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