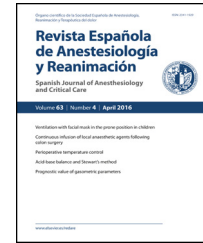




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CASE REPORT

The importance of bilateral monitoring of cerebral oxygenation (NIRS): Clinical case of asymmetry during cardiopulmonary bypass secondary to previous cerebral infarction[☆]

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KEYWORDS

Near infrared spectroscopy (NIRS);
Asymmetry;
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Multimodal neuromonitoring

Abstract Cerebral oximetry based on near infrared spectroscopy (NIRS) technology is used to determine cerebral tissue oxygenation. We hereby present the clinical case of a 12-month old child with right hemiparesis secondary to prior left middle cerebral artery stroke 8 months ago. The child underwent surgical enlargement of the right ventricular outflow tract (RVOT) with cardiopulmonary bypass. During cardiopulmonary bypass, asymmetric NIRS results were detected between both hemispheres. The utilization of multimodal neuromonitoring (NIRS-BIS) allowed acting on both perfusion pressure and anesthetic depth to balance out the supply and demand of cerebral oxygen consumption. No new neurological sequelae were observed postoperatively. We consider bilateral NIRS monitoring necessary in order to detect asymmetries between cerebral hemispheres. Although asymmetries were not present at baseline, they can arise intraoperatively and its monitoring thus allows the detection and treatment of cerebral ischemia-hypoxia in the healthy hemisphere, which if undetected and untreated would lead to additional neurological damage.

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PALABRAS CLAVE

Espectroscopia de infrarrojo cercano;
Asimetría;
Índice biespectral;

Importancia de la monitorización bilateral de la oxigenación cerebral: caso clínico de asimetría durante el bypass cardiopulmonar secundaria a infarto cerebral previo

Resumen La oximetría cerebral «near infrared spectroscopy» (NIRS) determina la oxigenación tisular cerebral. Describimos el caso clínico de un niño de 12 meses de edad con hemiparesia derecha secundaria a infarto de arteria cerebral media izquierda hacía 8 meses. El niño

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fue sometido a una ampliación del tracto de salida del ventrículo derecho por estenosis pulmonar mediante bypass cardiopulmonar. En periodos del bypass cardiopulmonar se detectan asimetrías NIRS entre ambos hemisferios cerebrales con descensos críticos en hemisferio derecho lo que indica estados de perfusión y consumo de oxígeno diferentes entre los 2 hemisferios. La utilización de neuromonitorización multimodal NIRS-BIS permitió actuar sobre la presión de perfusión y profundidad anestésica para equilibrar la balanza entre el aporte y el consumo de oxígeno cerebral. No se detectó daño neurológico sobreañadido en el postoperatorio.

Consideramos necesaria la monitorización NIRS bilateral para detectar asimetrías entre los 2 hemisferios, que aunque no se manifesten en el registro basal, pueden surgir en el periodo intraoperatorio, permitiendo detectar y tratar la isquemia-hipoxia cerebral en el hemisferio sano, que provocaría un daño neurológico sobreañadido.

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Introduction

Cerebral oximetry monitoring based on near infrared spectroscopy (NIRS) technology determines regional cerebral oxygenation (SrO₂) in the absence of pulsatile perfusion, and analyzes the relationship between delivery and consumption of oxygen in the brain. It can detect cerebral hypoperfusion, hypoxemia, hypocapnia, low hematocrit, and other situations leading to reduced cerebral oxygen saturation. Bilateral monitoring of the frontal region, perfused by the anterior and middle cerebral arteries,¹ analyzes 1 cm³ of the cortex in each hemisphere. The value of SrO₂ is mostly symmetrical (differences of around 10% are considered physiological). However, asymmetries are a result of different perfusion-oxygenation in each hemisphere which may be due to anatomical varieties in the Circle of Willis, cerebral embolism, excessive lateralization of the head during surgery, cannula malposition, selective cerebral perfusion, surgical clamping of the carotid artery or hyperperfusion syndrome after carotid revascularization.¹⁻³ NIRS monitoring is widespread in cardiac surgery with cardiopulmonary bypass (CPB).¹⁻⁷ Scientific evidence establishes the relationship between declines in cerebral oxygenation and neurological disorders^{4,6,8,9} and between rapid management of the potential causes and improved outcomes regarding both morbidity and mortality.^{8,9} Reductions of over 20% of baseline or saturations under 50% have been proposed as threshold values related to neurological complications.¹⁻⁹

We describe the first reported case of NIRS cerebral asymmetry during CPB in a child with a history of stroke and no baseline asymmetry. This shows the different consumption of oxygen in cerebral hemispheres in situations where oxygen transport may be compromised. We believe that this case supports the interpretation of NIRS records and contributes to the available evidence on this issue.

Clinical case

A 12-month old male child weighing 9 kg with a history of protein C deficiency and severe pulmonary valve

stenosis with patent foramen ovale (PFO). The child had been previously treated when he was 2 and 4 months old by percutaneous valvuloplasty. In the second procedure, paradoxical cerebral embolism was detected with left middle cerebral artery stroke (Fig. 1) leading to severe right hemiparesis and focal epilepsy, which was treated with anticonvulsants (levetiracetam) and anticoagulants (acencoumarol). At the time of the study, he presented an improvement of severe to mild hemiparesis, severe pulmonary valve stenosis, moderate tricuspid regurgitation and PFO. He underwent cardiac surgery with CPB for enlargement of the right ventricular outflow tract (RVOT), foramen ovale closure and tricuspid valvuloplasty. Monitoring consisted of femoral central venous pressure, femoral artery pressure, pulse oximetry, capnography, 5-lead EKG, ST analysis, nasopharyngeal and vesical temperature, analysis of blood gases, ions, acid-base balance, hematocrit, glucose, and diuresis.

Multimodal neuromonitoring consisted of bihemispheric transcranial cerebral oximetry based on NIRS technology (Invos, Covidien-Medtronic) and bispectral index (BIS). After aortic cannulation, CPB was initiated, and the circuit was primed with blood to achieve a 30% hematocrit, at an initial flow of 120 ml/kg/min, until 30 °C core temperature hypothermia was reached. The following NIRS changes were recorded in the different phases of surgery (Fig. 2).

- At the beginning of surgery, mean arterial pressure (MAP) ranged between 55 and 65 mmHg and normothermia was noted, no asymmetries were detected regarding SrO₂ in both hemispheres.
- The first asymmetric reading occurred after cannulation of superior vena cava and aorta and the initiation of CPB. The greatest decline was recorded in the right hemisphere (healthy hemisphere, ipsilateral to hemiparesis) with an initial decline to 55% after cannulation (31% decrease from baseline) later decreasing to 50% (37% decrease from baseline) with the initiation of CPB. SrO₂ on the left side only declined in 20% at this point. After ruling out cannula malposition, inadequate flow, or FiO₂, the asymmetry was attributed to low blood pressure and acute hemodilution.

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