Transient decrease of cerebral oxygen saturation during the emergence in children

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Lee et al. [1] had reported that regional cerebral oxygen saturation (rSO_2) decreases neither with an episode of arterial desaturation nor overt hemodynamic compromises during emergence in children. Following their study the authors suggested that the decrease of rSO_2 may correlate inversely with the fraction of anesthetic concentration (F_E) and the duration of anesthesia, and positively with the use of sevoflurane. This is the first report published on the change of cerebral oxygen saturation during the emergence of pediatric anesthesia.

Although brain is the primary target of general anesthetics, it is still the least monitored organ during general anesthesia. Anesthesia is usually managed by using indirect parameters of adequate brain oxygenation because central nervous system (CNS) monitoring is technically difficult and demanding. Furthermore, most CNS monitors are designed to monitor cerebral hemodynamics or electrical activity, including the measurement of intracranial pressure and cerebral blood flow and electroencephalography. Despite the existence of some invasive monitoring systems measuring brain oxygenation, the monitor cannot be performed routinely for all anesthetized patients because of its severe complications. In some surgical field, cardiovascular- and neurosurgery, postoperative neurological complication remains an important cause of increasing morbidity and mortality. Neurologic complications in the anesthetized patient can be followed by a devastating result for the patient and their family. Therefore, monitoring and prevention of neurologic complication are important.

Ferrari et al. [2] reported the studies about first human cerebral oximetry, using near-infrared spectroscopy (NIRS) in 1985. Technology of NIRS has developed to allow continuous, non-invasive, and bedside monitoring of rSO_2 by providing

information on the balance between brain oxygen supply and demand. Cerebral perfusion is a major factor for regional and global imbalance in oxygen supply and demand, which may result in brain injury. Similar to pulse oximetry, cerebral oximetry is the method to monitor regional cerebral perfusion. While pulse oximeter measures oxygen saturation of hemoglobin in arterial blood, cerebral oximeter measures oxygen saturation in the brain tissue, arterial, and venous blood. Since the ratio of arterial and venous blood is about 15 : 85, NIRS primarily measures cerebral venous saturation, which reflects the oxygen balance in the brain. Several studies reported normative rSO_2 ranges from 55 to 77% [3-5]. Because of wide individual variation of baseline rSO_2 values, the percentage decreases from baseline of 15–20% seems to be the best threshold indicating the occurrence of cerebral ischemia [6]. Several studies also have shown that there is a significant increase in the incidence of cognitive impairment or neurologic injury in patients whose rSO_2 values declined below 50% even in brief periods [7,8].

General anesthesia has the potential to disrupt the cerebral oxygen balance. The results of cerebral oxygen imbalance may range from slight change in cognitive decline to severe neurological complications such as acute brain ischemia with serious permanent functional impairment. Unfortunately, however, these risks remain totally undiagnosed during anesthesia if we do not specifically monitor it. The incidence of neurologic complications is particularly high in patients undergoing cardiovascular operation. For instance, more than 40% of patients undergoing cardiac operations develop cognitive and functional impairment [9,10]. Carotid endarterectomy (CEA) is a human model of regional cerebral

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ischemia, providing an ideal opportunity for validation of cerebral oximetry. Perioperative incidence of stroke in CEA is 5–7.5% [11,12]. Patients with neurosurgical problems, such as vasospasm, stroke, or head trauma, are at risk of cerebral ischemia because of the oxygen imbalance. Moreover, elderly patients are at increased risk for postoperative neurologic complications. Casati et al. [13] reported that the occurrence of cognitive dysfunction was associated with a higher incidence of intraoperative cerebral desaturation in aged patients. There are many publications supporting that the use of cerebral oximetry in several clinical conditions to guide treatment can result in cost-effective reduction of neurologic injuries and hospital stay. However, further large clinical trials should be required to evaluate the cost-effectiveness of routinely applying this new technology.

If arterial oxygen content and cerebral perfusion are normal during general anesthesia, cerebral oxygen balance is maintained. In general, rSO_2 may show upper normal value or higher than the preanesthetic value during general anesthesia because most anesthetics decrease cerebral metabolism (cerebral oxygen demand) while it effects the cerebral blood flow independently. Lee et al. [1] have reported that rSO_2 decreases during emergence in children. Although the decreased rSO_2 result is within normal range in the study, it means as increased cerebral oxygen consumption during emergence. It is a predictable result because cerebral oxygen consumption is increased at emergence in comparison with anesthesia maintenance period while the cerebral perfusion is maintained. However, relationship between the decreased rSO_2 and F_{iO_2} and its relation to duration of anesthesia, and use of sevoflurane are questionable. In the reported study, the authors bring up a number of questions worth discussing. As for example, Is the phenomenon observed with intravenous agents? Is it seen in adults too? Does the rapid recovery from general anesthesia intensify the decrease of rSO_2 ? Does the type of volatile anesthesia have a different effect on the rSO_2 ? And is the cerebral desaturation related to the key clinical outcomes, such as emergence delirium/agitation, convulsion, and ischemic events, particularly in children are at cerebral risk? Although the decreased rSO_2 is not a clinically significant value in this study, the results give clues to many anesthesiologists about unsolved and unanswered anesthetic problems including emergence delirium/agitation. Therefore, further studies are needed on the change of rSO_2 using cerebral oximetry for answering these questions.

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