Intraoperative motor evoked potential monitoring

Postoperative motor dysfunction can develop after spinal surgery, neurosurgery and aortic surgery, in which there is a risk of injury of motor pathway. In order to prevent such devastating complication, intraoperative monitoring of motor evoked potentials (MEP) has been conducted. However, to prevent postoperative motor dysfunction, proper understanding of MEP monitoring and proper anesthetic managements are required. Especially, a variety of anesthetics and neuromuscular blocking agent are known to attenuate MEP responses. In addition to the selection of anesthetic regime to record the baseline and control MEP, the measures to keep the level of hypnosis and muscular relaxation at constant are crucial to detect the changes of MEP responses after the surgical manipulation. Once the changes of MEP are observed based on the institutional alarm criteria, multidisciplinary team members should share the results of MEP monitoring and respond to check the status of monitoring and recover the possible motor nerve injury. Prevention of MEP-related adverse effects is also important to be considered. The Working Group of Japanese Society of Anesthesiologists (JSA) developed this practical guide aimed to help ensure safe and successful surgery through appropriate anesthetic management during intraoperative MEP monitoring [1].

Tanaka et al. from the IMS Miyoshi General Hospital published a study were motor evoked potential monitoring was performed during 484 neurosurgical operations for patients without definitive preoperative motor palsy including 325 spinal operations, 102 cerebral aneurysmal operations, and 57 brain tumor operations, all monitored by transcranial stimulation, and 34 brain tumor operations monitored under direct cortical stimulation. To exclude the effects of muscle relaxants on MEP, the compound muscle action potential (CMAP), measured immediately after transcranial stimulation or direct cortical stimulation at supramaximal stimulation of the peripheral nerve, was used for normalization. The cutoff points, sensitivity, and specificity of MEP recorded during neurosurgery were examined by receiver operating characteristic (ROC) analyses and categorized according to the type of operation and stimulation.

In spinal operations under transcranial stimulation, amplitude reduction of 77.9% and 80.6% as cutoff points for motor palsy with and without CMAP normalization, respectively, provided a sensitivity of 100% and specificity of 96.8% and 96.5%. In aneurysmal operations under transcranial stimulation, cutoff points of 70.7% and 69.6% offered specificities of 95.2% and 95.7% with and without CMAP normalization, respectively. The sensitivities for both were 100%. In brain tumor operations under direct stimulation, cutoff points were 83.5% and 86.3% with or without CMAP normalization, respectively, and the sensitivity and specificity for both were 100%.

An amplitude decrease of 80% in brain tumor operations, 75% in spinal operations, and 70% in aneurysmal operations should be used as the cutoff points [2].

In 2013, the following intraoperative MEP recommendations was made on the basis of current evidence and expert opinion: (1) Acquisition and interpretation should be done by qualified personnel. (2) The methods are sufficiently safe using appropriate precautions. (3) MEPs are an established practice option for cortical and subcortical mapping and for monitoring during surgeries risking motor

injury in the brain, brainstem, spinal cord or facial nerve. (4) Intravenous anesthesia usually consisting of propofol and opioid is optimal for muscle MEPs. (5) Interpretation should consider limitations and confounding factors. (6) D-wave warning criteria consider amplitude reduction having no confounding factor explanation: >50% for intramedullary spinal cord tumor surgery, and >30-40% for peri-Rolandic surgery. (7) Muscle MEP warning criteria are tailored to the type of surgery and based on deterioration clearly exceeding variability with no confounding factor explanation. Disappearance is always a major criterion. Marked amplitude reduction, acute threshold elevation or morphology simplification could be additional minor or moderate spinal cord monitoring criteria depending on the type of surgery and the program's technique and experience. Major criteria for supratentorial, brainstem or facial nerve monitoring include >50% amplitude reduction when warranted by sufficient preceding response stability. Future advances could modify these recommendations [3)].

In 2006 the same author published Intraoperative motor evoked potential monitoring: overview and update [4)].

In 2000 Kakimoto et al., reviewed the experiences of intraoperative motor evoked potentials (MEPs) monitoring for 115 operations on the spine or spinal cord. They observed compound muscle action potentials from bilateral anterior tibial muscles by electrical transcranial stimulation of the motor cortex under general anesthesia induced and maintained with intravenous anesthetics (ketamine, propofol, or droperidol), fentanyl, and 50% nitrous oxide. Partial neuromuscular blockade was obtained with continuous infusion of vecuronium. MEPs were recorded bilaterally in 91 cases (79%) and laterally in 18 cases (16%). Postoperative deterioration of motor function was observed in 2 cases and amplitude of MEPs decreased more than 50% of control values in both cases. Intraoperative monitoring of MEPs might be a reliable indicator of spinal cord motor function [5)].

Nagle et al., in 1996 reviewed the results of motor evoked potential (MEP) and somatosensory evoked potential (SEP) monitoring during 116 operations on the spine or spinal cord. We monitored MEPs by electrically stimulating the spinal cord and recording compound muscle action potentials from lower extremity muscles and monitored SEPs by stimulating posterior tibial or peroneal nerves and recording both cortical and subcortical evoked potentials. We maintained anesthesia with an N2O/O2/opioid technique supplemented with a halogenated inhalational agent and maintained partial neuromuscular blockade using a vecuronium infusion. Both MEPs and SEPs could be recorded in 99 cases (85%). Neither MEPs nor SEPs were recorded in eight patients, all of whom had preexisting severe myelopathies. Only SEPs could be recorded in two patients, and only MEPs were obtained in seven cases. Deterioration of evoked potentials occurred during nine operations (8%). In eight cases, both SEPs and MEPs deteriorated; in one case, only MEPs deteriorated. In four cases, the changes in the monitored signals led to major alterations in the surgery. We believe that optimal monitoring during spinal surgery requires recording both SEPs and MEPs. This provides independent verification of spinal cord integrity using two parallel but independent systems, and also allows detection of the occasional insults that selectively affect either motor or sensory systems [6)].

References

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