Transcranial motor evoked potential monitoring

Transcranial electrical MEPs could be implemented during neurosurgery in infants between 1 and 3 months of age. Intraoperative MEP monitoring may be a safe adjunct for neurosurgical procedures in these very young patients [1].

Two stimulation modalities have been established to elicit MEPs—Transcranial direct current stimulation (TES) and direct cortical stimulation.

MEP has become popular due to the recent rapid advances with propofol anesthesia and the train stimulation method [2] [3].

In adult neurosurgical patients with a normal motor status, a train of 5 pulses and an interstimulus interval (ISI) of 3 ms provide the lowest motor thresholds. Joksimovic et al. provided evidence of the dependence of required stimulation current on ISI [4].

Continuous motor mapping using subcortical stimulation via a surgical aspirator, in comparison with the sequential use of a standard monopolar stimulation probe, is a feasible and safe method without any disadvantages. Compared with the standard probe, the aspirator offers continuous information on the distance to the corticospinal tract [5].

Vasospasm following aneurysmal subarachnoid hemorrhage (aSAH) can be detected accurately by using MEPs. MEPs are a feasible bedside tool for online VS detection in an intensive care unit and, therefore, may complement existing diagnostic tools [6]

Redondo-Castro et al have applied Transcranial direct current stimulation to rats with spinal cord injury and selectively tested the motor evoked potentials (MEPs) conveyed by descending motor pathways with cortical and subcortical origin. MEPs were elicited by Electrostimulation to the brain and recorded on the tibialis anterior muscles. Stimulation parameters were characterized and changes in MEP responses tested in uninjured rats, in rats with mild or moderate contusion, and in animals with complete transection of the spinal cord. All injuries were located at the T8 vertebral level. Two peaks, termed N1 and N2, were obtained when changing from single pulse stimulation to trains of 9 pulses at 9 Hz. Selective injuries to the brain or spinal cord funiculi evidenced the subcortical origin of N1 and the cortical origin of N2. Animals with mild contusion showed small behavioral deficits and abolished N1 but maintained small amplitude N2 MEPs. Substantial motor deficits developed in rats with moderate contusion, and these rats had completely eliminated N1 and N2 MEPs. Animals with complete cord transection had abolished N1 and N2 and showed severe impairment of locomotion. The results indicate the reliability of MEP testing to longitudinally evaluate over time the degree of impairment of cortical and subcortical spinal pathways after spinal cord injuries of different severity [7].

Intraoperative neuromonitoring of motor evoked potentials (MEPs) via transcranial stimulation of the motor cortex has become a commonly used technique, which allows preserving functional integrity of descending motor pathways during brain and spinal cord surgery. However, this technique is not reliable in all cases, as the elicited myogenic responses may be very sensitive to suppression by anesthetics and neuromuscular blocker.

AKA motor evoked potentials (MEP): transcranial electrical or magnetic stimulation of motor cortex and descending motor axons with recording of motor potentials from distal spinal cord or muscle groups. Using direct Electrostimulation is limited in awake patients by local pain. Due to the large potentials, the acquisition time is shorter and feedback to the surgeon is almost immediate. However, due to patient movement from the muscle contractions, continuous recording is usually not possible (except with monitoring the response over the spinal cord). Useful for surgery involving the spinal cord (cervical or thoracic), no utility for lumbar spine surgery. Seizures occur rarely, usually in patients with increased seizure risk and with high-rate stimulation frequency

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see Transcranial motor evoked potential monitoring of the facial nerve

MEP monitoring is useful for evaluating the safety of prolonged temporary occlusion (PTO), surgical strategy, and outcomes of giant ICA aneurysm surgery. Direct clipping during safe PTO under intraoperative MEP monitoring is applicable for giant ICA aneurysms. Its use achieved favorable outcomes by indicating the need for bypass surgery [8].

Case series

The aim of a study of Abboud et al. from the Department of Neurosurgery, University Medical Center Hamburg-Eppendorf and Department of Neurosurgery, University Medical Center Göttingen,Germany, was to compare sensitivity and specificity between the novel threshold and amplitude criteria for motor evoked potentials (MEPs) monitoring after transcranial Electrostimulation (TES) during surgery for supratentorial lesions in the same patient cohort.

One hundred twenty-six patients were included. All procedures were performed under general anesthesia. Craniotomy did not expose motor cortex, so that direct mapping was less suitable. After TES, MEPs were recorded bilaterally from abductor pollicis brevis (APB), from orbicularis oris (OO), and/or from tibialis anterior (TA). The percentage increase in the threshold level was assessed and considered significant if it exceeded by more than 20% on the affected side the percentage increase on the unaffected side. Amplitude on the affected side was measured with a stimulus intensity of 150% of the threshold level set for each muscle.

Eighteen of 126 patients showed a significant change in the threshold level as well as an amplitude reduction of more than 50% in MEPs recorded from APB, and 15 of the patients had postoperative deterioration of motor function of the arm (temporary in 8 cases and permanent in 7 [true-positive and false-negative results]). Recording from TA was performed in 66 patients; 4 developed postoperative deterioration of motor function of the leg (temporary in 3 cases and permanent in 1), and showed a significant change in the threshold level, and an amplitude reduction of more than 50% occurred in 1 patient. An amplitude reduction of more than 50% occurred in another 10 patients, without a significant change in the threshold level or postoperative deterioration. Recording from OO was performed in 61 patients; 3 developed postoperative deterioration of motor function of facial muscles (temporary in 2 cases and permanent in 1) and had a significant change in the threshold level, and 2 of the patients had an amplitude reduction of more than 50%. Another 6 patients had an amplitude reduction of more than 50% but no significant change in the threshold level or postoperative deterioration. Sensitivity of the threshold criterion was 100% when MEPs were recorded from APB, OO, or TA, and its specificity was 97%, 100%, and 100%, respectively. Sensitivity of the amplitude criterion was 100%, 67%, and 25%, with a specificity of 97%, 90%, and 84%, respectively.

The threshold criterion was comparable to the amplitude criterion with a stimulus intensity set at 150% of the threshold level regarding sensitivity and specificity when recording MEPs from APB, and superior to it when recording from TA or OO [9].

Contraindications

1. history of epilepsy/seizures

2. past surgical skull defects

3. metal in head or neck

4. use special care with implanted electronic devices

1)

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