Neurophysiologic Monitoring in Neurosurgery

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KEYWORDS

• Monitoring • Electroencephalography • Somatosensory-evoked potentials
• Electromyography • Motor-evoked potentials

KEY POINTS

- Neurophysiologic mapping and monitoring improve surgical decision making, refines procedures, and reduces undesired neural morbidity.
- Intraoperative monitoring (IOM) allows the neurosurgeon to better find the functional tissues put at risk by their procedures.
- IOM enhances the effectiveness of the surgery and reduces the risk of undesired morbidity.

INTRODUCTION

Neurophysiologic monitoring, often referred to as intraoperative monitoring (IOM), is commonly used in the operating room to improve surgical decision making and patient outcome. Recent articles and textbooks have extensively reviewed the methodology, patient physiology, anatomy, and impact of anesthesia drugs on neurophysiologic monitoring.[1–5] Most reviews and publications focus on spine surgery. In contrast, this article focuses on the application of monitoring in neurosurgical procedures. IOM for neurosurgery focuses on identifying and preserving functional areas of the central nervous system.

IOM combines with new developments in imaging to identify specific neurologic functions so the surgical approach to disease can avoid key areas, and identify specific target regions for tissue resection, lesioning, or stimulation. These monitoring techniques allow surgical procedures on neural structures previously avoided because the risk of disability outweighed the benefit of treatment. IOM contributes to prevention of surgical incursions into adjacent functional structures. These techniques depend on the unique tissue characteristics to allow neurophysiologic stimulation or recording. These techniques are useful for procedures on the brain, brainstem, spinal cord, and peripheral nervous system.

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Anesthesiology Clin 30 (2012) 311–331
doi:10.1016/j.anclin.2012.05.005 anesthesiology.theclinics.com

MONITORING IN THE CEREBRAL CORTEX

Electrocorticography (ECoG) was one of the first applications of IOM in neurosurgery. With ECoG, the recording electrodes are placed directly on or in the brain to record neuronal activity. This characteristic is in contrast to electroencephalography (EEG), in which the recording electrodes are located on the scalp. EEG and ECoG are often incorrectly used interchangeably. ECoG is commonly used to identify and then map the precise location of seizure foci or the edges of tumor. To remove a seizure locus, ECoG recordings can be performed in the operating room or postoperatively in specialized units designed to monitor seizure activity via ECoG grid recordings. Recording electrodes (cortical grids) are placed over brain areas that are suggested by magnetic resonance imaging (MRI), functional MRI, or positron emission tomography imaging to be the source of seizure activity (**Fig. 1**).[6] Over the next 3 to 5 days, continuous ECoG recording allows the neurologist and neurosurgeon to locate the area involved in the seizure activity. A repeat craniotomy is performed and seizure foci are removed. Depending on the location and the preference of the surgeon, the anesthetic management can either be a general anesthetic or awake with minimal sedation. In both situations, direct brain stimulation may be performed to induce

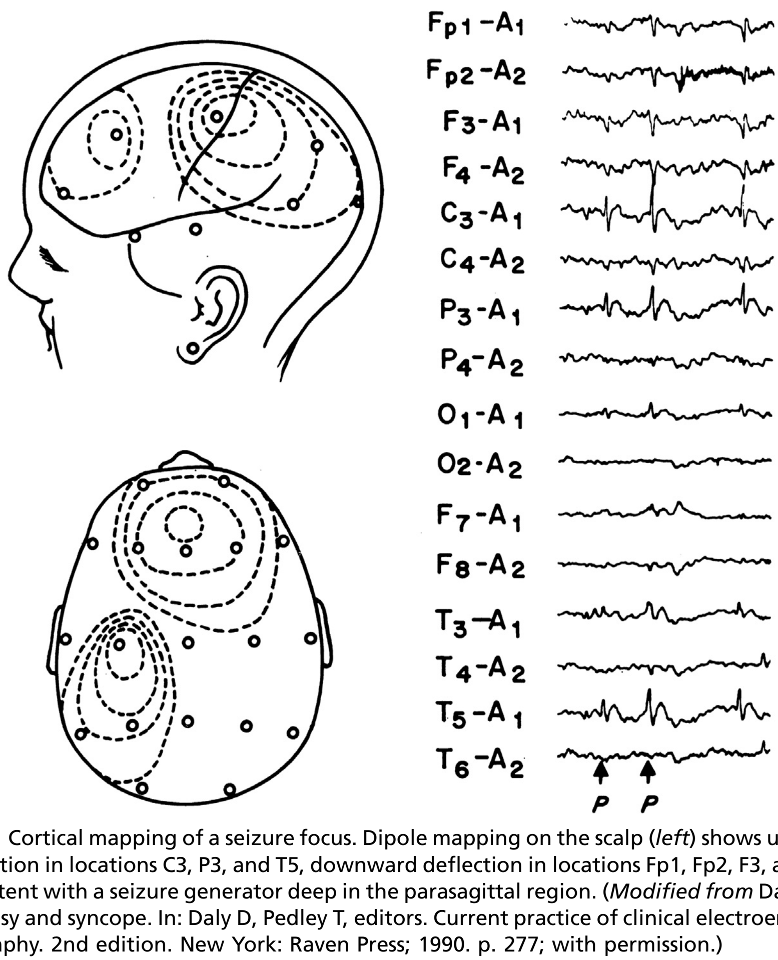

Fig. 1. Cortical mapping of a seizure focus. Dipole mapping on the scalp (*left*) shows upward deflection in locations C3, P3, and T5, downward deflection in locations Fp1, Fp2, F3, and F4, consistent with a seizure generator deep in the parasagittal region. (*Modified from* Daly DD. Epilepsy and syncope. In: Daly D, Pedley T, editors. Current practice of clinical electroencephalography. 2nd edition. New York: Raven Press; 1990. p. 277; with permission.)