Neurophysiologic monitoring during cranial base surgery

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Key words: neurophysiologic monitoring, evoked potentials, EMG, cranial base, tumors

Summary

The last decade has seen a rapid growth in surgical techniques directed at resection of skull base tumors. Lesions that were previously inoperable can now be resected either partially or in some cases completely. The morbidity in these procedures has diminished with increased surgical experience. Additional aids to successful surgical resection include intraoperative neurophysiologic monitoring techniques. The following text outlines methods of monitoring cranial nerve and brain function in a manner that is directly relevant to cranial base surgery in which so many structures are potentially at risk. These techniques permit the identification of nerves obscured by tumor before they may be inadvertently damaged, the repeated confirmation during tumor resection that a nerve is still functional, and infer the state of brain and brainstem function during the course of long surgical procedures to help signal vascular compromise, or the effects of brain retraction. These techniques can only help to enhance the safety of the long and complex procedures required for successful resection of tumors of the cranial base.

Introduction

The possible neurologic structures that are threatened during extensive cranial base procedures include all of the cranial nerves, the brainstem, and the cerebrum either directly from retraction or indirectly through vascular injury. Neurophysiologic monitoring may be helpful as an early warning system of compromise of any one of these structures. This chapter will consider event related potentials that can be monitored including brainstem auditory evoked potentials, visual evoked potentials, somatosensory evoked potentials, trigeminal evoked potentials, as well as motor cranial nerve monitoring. While EEG may be of some value as a functional monitor of cerebral blood flow, it will not be discussed in this chapter.

Monitoring event-related potentials during surgery to reflect brain function serves the main purpose of providing an early warning system of the possibility of irreversible neurologic damage if corrective action through altering surgical technique is not taken. Since a compromised neuron will show alterations in its excitable properties before irreversible metabolic damage to the cell occurs, this property can be exploited and surgical technique may be altered at a sufficiently early time to prevent a permanent neurologic deficit from occurring. Monitoring of the motor cranial nerves has a duality in purpose; 1) it permits the early electrophysiologic localization of cranial nerves that are obscured by tumor, and in identifying aberrant anatomy devoid of the usual landmarks owing to tumor distortion, and 2) it allows the repeated confirmation of function by electrical stimulation, as well as the signaling the direct or indirect mechanical effects of manipulation and resection of tumor on the nerves.

The following description outlines comprehensive techniques for monitoring cranial nerve and brain functions during cranial base surgery. In gen-
eral, if a structure is going to be exposed in a procedure, or is intimately apposed to, or invaded by a lesion, then its function should be monitored electrophysiologically. This philosophy should serve to aid in the selection of which combination of the following tests will be most appropriate for a given surgical procedure.

**Effects of anesthesia**

The effects of anesthesia on intraoperative monitoring may be so profound as to make it impossible to obtain a signal unless the neuroanesthesiologist is cognizant of the goals of the neurophysiology monitoring team. Preoperative discussion is helpful in preparation. The particular anesthetic considerations that are relevant to each modality will be discussed in each section.

**Brainstem auditory evoked potentials**

Brainstem auditory evoked potentials (BAEP) are of value in cranial base surgery in allowing monitoring of the function of both the extra-axial auditory nerve, as well as the intra-axial auditory brainstem circuitry. The short latency BAEP involves 5 principle waves that are generated from the proximal eighth nerve (I), the eighth nerve root entry zone (II), the cochlear nuclear complex (III), the region of the superior olive (IV), and the contralateral lateral lemniscus or its nucleus (V) [1, 2]. These events occur in the first 6 msec following the stimulus.