EDITORIAL

EVOKED RESPONSES—A NEUROPHYSIOLOGICAL INDICATOR OF DEPTH OF ANAESTHESIA?

The introduction of balanced anaesthetic techniques involving the use of neuromuscular blocking drugs has made the assessment of the depth of anaesthesia more difficult, because respiratory pattern and spontaneous movement are no longer available as signs of inadequate anaesthesia. Assessment of the depth of anaesthesia is now carried out by monitoring the autonomic responses to surgery, but this is not wholly satisfactory as demonstrated by an incidence of awareness during balanced techniques. Furthermore, these responses may be modified by a variety of drugs in increasingly common usage, for example beta-blocking agents. Alternative approaches which have been proposed include scoring systems based on traditional vital signs, the isolated forearm technique, spontaneous and evoked lower oesophageal contraction, integrated frontalis EMG and skin resistance (Evans and Davies, 1984). None of these has achieved routine acceptance although oesophageal contraction techniques have not been fully evaluated as yet.

More direct measures of central nervous activity utilizing electroencephalography (EEG) have also been investigated but have been found generally unsatisfactory because changes are agent specific, difficult to interpret, and show wide inter-patient variations. Methods of automated analysis of the EEG have also received interest, for example the cerebral function monitor (CFM), cerebral function analysing monitor (CFAM), compressed spectral array, power spectral edge and aperiodic analysis, but these also suffer from the basic objections stated above.

Before discussing the potential applications of evoked responses, we should define the requirements of an indicator of depth of anaesthesia. It should show graded responses to changing depth of anaesthesia at all levels from light sedation to deep surgical anaesthesia. It should be independent of anaesthetic technique and respond to surgical stimulus when anaesthesia is inadequate. The indicator should be easily quantified, readily interpreted, and be unaffected by such routine operating theatre interference as electrocautery.

We have been interested in the application of specific central nervous system evoked responses to this problem. These responses can be easily obtained by repetitive presentation of a suitable stimulus whilst simultaneously recording the EEG signal from scalp electrodes. This signal is amplified, digitized, then averaged on line using a computer technique, thus selectively enhancing the stimulus-related EEG and eliminating unrelated background activity. The most practical techniques in common neurophysiological use involve stimulation of visual, auditory and somatosensory pathways. They have been shown to be applicable to operating theatre use for monitoring regional ischaemia during neurosurgery (Grundy, 1983).

The potential application of evoked responses to monitor depth of anaesthesia has been demonstrated by Uhl and colleagues (1980). Increasing concentrations of halothane were shown to produce graded increases in the latency of the first major positive potential (P1) of the cortical visual evoked response. Since then we and our colleagues have systematically studied the effects of a wide variety of anaesthetic agents on the three modalities of evoked response. In doses in the clinical range, the inhalation agents, halothane, enflurane and isoflurane all increase latencies of the early (brainstem) and middle latency components of the auditory response and reduce the amplitude of the middle latency components (Thornton et al., 1983; Thornton et al., 1984; Navaratnarajah et al., 1985; Sebel et al., 1985). Isoflurane also increases the latency and decreases the amplitude of the cortical somatosensory and visual evoked responses (Sebel et al., 1985). Nitrous oxide given alone in concentrations up to 50% decreases the
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amplitude of cortical somatosensory and visual evoked responses, but has no effect on latency of the cortical somatosensory, visual or brainstem auditory components (Sebel, Flynn and Ingram, 1984). Althesin and etomidate have a similar effect on the middle latency components to the halogenated agents but have no effect on the brainstem responses (Navaratnarajah et al., 1983; Heneghan et al., 1984). Other workers have demonstrated that fentanyl 50 μg kg⁻¹ has no effect on brainstem responses (Samra et al., 1984). These results confirm previous observations that brainstem responses are robust, and even with the halogenated agents the changes seen were of small magnitude. They are therefore of limited application to measurement of depth of anaesthesia. However, the cortical components of all three stimulus modalities are profoundly affected by all drugs studied in a graded, reversible and non-agent-specific manner. As such they hold promise as measures of depth of anaesthesia.

Further work is required before these techniques can be shown to fulfil our ideal criteria. First, although we have shown graded changes with changing anaesthetic concentration, we have not yet established any relationship with the patient's response during surgery. This may prove difficult as there is no standard reference for depth of anaesthesia. Second, interpretation of recordings of evoked responses requires some training in identifying the various components, particularly when signal-to-noise ratio is low, as may occur during deep anaesthesia. However, future advances in automated peak identification may obviate this problem. Third, the effect of temperature should be considered. Hypothermia increases latency and decreases amplitude in a manner similar to anaesthetic agents, although it is not clear whether this is related to the anaesthetic effects of hypothermia or merely to a physical effect on central nervous conduction. Finally, we must consider the effects of drug mixtures. Most studies have involved the effect of a single drug, so that little is known about the effects of drug interactions and whether mixtures are additive or whether synergism occurs.

The final index that is used for anaesthetic evoked response monitoring may need to be a function of both latency and amplitude. When these points have been resolved, evoked response measurements should provide a convenient and reliable neurophysiological indicator of depth of anaesthesia.

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REFERENCES


