A diagnosis is established using differential neural blockade not by correlating what concentration of local anesthetic has been injected (including zero per cent) with the onset of pain relief, but rather by correlating what modality has been blocked with the onset of pain relief. Just as one could not make a diagnosis of a sympathetic mechanism if a stellate ganglion block with local anesthetic does not produce a Horner's syndrome, similarly one cannot make a diagnosis of a psychogenic mechanism if the injection of a "placebo" does produce a Horner's syndrome. This concept is absolutely essential if differential neural blockade is to be used effectively in the differential diagnosis of pain mechanisms.

A Further Statement on Automated EEG Processing for Intraoperative Monitoring

To the Editor:—With their article, "Automated EEG Processing for Intraoperative Monitoring," Levy et al.¹ have in our opinion, rendered a service to anesthesiologists by sorting out and clarifying the several EEG analytical systems under development at this time. In their article they credit us with having worked on what appear to be two systems of EEG analysis: "multiple differential analysis" and "period amplitude analysis," thus potentially creating the impression that we have developed two different EEG analytical techniques. We wish to point out with a short explanation of our technique, that these are not two analytical systems, but rather, what the authors call "period amplitude analysis" (PAA) is actually a subset of a larger analytical system which they refer to as "multiple differential analysis." In our original publications we preferred to use the expression "derivative analysis" instead of "multiple differential analysis" to refer to the larger technique, and hence will use this former terminology for our explanations presented here.

In 1976 we described our method of derivative analysis and its performance under different conditions of anesthesia.² The method used a six-parameter, time domain derivative, wave analyzer based in part upon period analysis.³ ⁴ For a given single-channel EEG input, this analog analyzer extracts the following six features from the incoming EEG wave:

F0: The number of zero-axis crossings of the original wave, per unit time. This parameter is referred to as basic frequency (Units: hertz).

A0: The average rectified amplitude of the original wave. This parameter is referred to as basic amplitude (Units: volts).

F1: The number of zero-axis crossings of the first derivative of the original wave, per unit time. This parameter is referred to as first derivative frequency (Units: hertz).

A1: The average rectified amplitude of the first derivative of the original wave. This parameter is referred to as first derivative amplitude (Units: volts/s).

F2: The number of zero-axis crossings of the second derivative of the original wave, per unit time. This parameter is referred to as second derivative frequency (Units: hertz).

A2: The average rectified amplitude of the second derivative of the original wave. This parameter is referred to as second derivative amplitude (Units: volts/s²).

It is the first two parameters (F0, A0) which Levy et al. refer to when they speak of "period amplitude analysis" (PAA). Our F0 parameter, corresponds to their zero cross frequency (ZXF), and our A0 parameter corresponds to their mean rectified voltage (MRV). We are more comfortable with the notion that we have developed one system of EEG analysis of which it is often adequate to use only the lower two parameters (F0,A0) for particular applications.

We have in fact spent some time in developing and
clinically testing a system based upon the use of these lower two parameters. We have found this system to be very useful for many, but not all, clinical situations. We have added to this simpler EEG analyzer system, the simultaneous monitoring of the EMG from the same EEG electrodes. The EMG provides an indication of both EEG muscle contamination and the state of relaxation of the patient. The use of the zero-axis crossing frequency and the average rectified amplitude of the fundamental EEG wave is particularly effective when the anesthetic agent and given dosage produces an EEG whose frequency spectrum is reasonably well-defined and unimodal. The simpler technique does not provide as complete a waveform analysis when the anesthetic type or given dosage produces a bimodal spectral response where we have a significant amount of EEG activity at two widely separated frequencies. It has been our experience that many of the clinical dosage levels of halothane, enflurane and nitrous oxide do in fact have a reasonably well-defined, unimodal spectral response, and hence the simpler EEG analytical system is indeed effective with these agents.

We wish to point out that we have not abandoned or lost interest in the more complicated form of the derivative analysis which includes all six parameters. For example, Levy et al. correctly point out in their figures 6 and 7 that the basic EEG zero-axis crossing frequency (F0) does not respond to off-axis maxima and minima and thus, in certain cases can give an erroneous indication of the rhythms within the EEG wave. It can be seen through the calculations that first derivative zero-axis crossing frequency (F1) detects basic undifferentiated wave maxima and minima irrespective of whether or not there is an actual axis crossing of the basic wave. This higher-order parameter would then be useful in detecting situations where there is considerable off-axis EEG activity. The second derivative zero-axis crossing frequency (F2) looks further into the basic EEG wave, in that it is a measure of the frequency of the inflection points of the basic undifferentiated wave.

A question in which we are most interested is, How much sensitivity or ability to look further and further into an EEG wave is necessary for every day clinical monitoring use? We have attempted to address this question for two anesthetic agents in a paper just completed which documents the use of the 6-parameter derivative EEG analytical technique working along with cardiovascular parameters in discriminating among several dosage levels of the agents, halothane and enflurane, as used with nitrous oxide. In this study we allow a stepwise discriminant analysis to "pick" the most effective EEG and/or cardiovascular parameters for separating the chosen anesthetic dosages. For the anesthetic agents and dosages used in the study, the discriminant analysis picked the basic EEG zero-axis crossing frequency (F0) as the best discriminator among the dosages, followed by higher-order EEG parameters, followed by cardiovascular parameters. The study made clear to us that basic EEG frequency (F0) was a good discriminator between anesthetic dosages for the agents and dosages tested, but that clearly significant improvement in separating anesthetic dosages could be attained by the use of the additional EEG parameters and the cardiovascular parameters.

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References

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A Simple In-circuit Vaporizer for Closed-circuit Anesthesia

To the Editor:—Introduction of volatile liquid anesthetics into a low-flow or closed, carbon dioxide absorption circuit is facilitated by providing a controllable injection port on the expiratory limb of the circuit close to the absorber. No such port is commercially available.