

Title: SEIZURE DETECTION USING THE PROCESSED EEG

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Introduction:

Electroencephalography (EEG) is clinically useful for the detection of changes in depth of anesthesia, ischemia and cerebral metabolic state.¹ Microcomputer based EEG analyzers have recently been introduced to simplify the detection and interpretation of these changes. Seizure detection is commonly cited as an advantage of EEG monitoring in the paralyzed patient. While the raw EEG during grand mal seizures is well described, the appearance of such seizures on the processed EEG display is not well documented. The purpose of this investigation was to document the appearance of grand mal seizures on four different EEG displays and examine the similarities and differences between them.

Methods:

The study was approved by the University Human Subjects Ethics Committee. Patients for electroconvulsive therapy (ECT) were selected for cardiovascular fitness and after informed consent, randomized to receive either methohexital 1.0 mg/kg IV or etomidate 0.3 mg/kg IV for sedation prior to ECT. As a part of this comparative study, bilateral EEGs (FP1-01, FP2-02) were recorded. Omniprep and isopropyl alcohol skin preparation preceded placement of pregelled adhesive electrodes (Neurometrics, Inc.). On-line analysis of the EEG (Neurotrac) allowed quantitation of electrode impedance which were adjusted to < 5 kohms. All EEGs were recorded on FM tape (Vetter C4) with a calibration signal equivalent to 100 μ V of EEG at 12 Hz.

EEG was played back to observe the pre-induction, postinduction pre-seizure, seizure, post-ictal and recovery periods. Raw EEG was replayed on an AstroMed Recorder MT80500 at 25 mm/sec paper speed. The same EEG was replayed using the following analysis techniques: aperiodic analysis-(L) Lifescan (Neurometrics), Fourier analysis (CSA)-(NE) Neurotrac (Interspec) and (PA) Pathfinder II (Nicolet), Parametric analysis-(DA) Datasmith experimental.² The EEG analyzers were configured as follows: L(A) - 5 min/screen, 200 μ V scale, amplitude display; L(B) - 5 min/screen, 100 μ V scale, $\Sigma(\text{amplitude})^2$ L(A) and L(B) spectral edge 90% 60 Hz filter; NE - 8 sec. epochs, 90% spectral edge, 60 μ V p-p gain; PA - 8 sec. epochs, 100 μ V p-p gain, 60 Hz filter; and DA - 8 sec. epochs, 200 μ V p-p gain, 60 Hz filter.

Results:

The slow induction of light anesthesia prior to the ECT was subtle using L, NE, PA but more apparent using DA. Immediately following ECT, the amplitude of the EEG envelope (0-30 Hz) increased. PA, NE and DA displayed greatest power at 0-15 Hz which peaked over this range during the seizures.

Sometimes immediately following the seizures, a characteristic period of post ictal silence was prominent on the L(A) and L(B) but easily detected on the NE, PA and DA by absence of electrical activity and loss of EEG power. Gradual return of EEG began with appearance of increasing power at lower frequencies (0-10 Hz), spreading to higher frequencies (10-15 Hz) over several minutes. At the time of return to verbal command, the processed EEG still was not normal with respect to the pre-induction appearance.

Discussion:

Among the advantages of intra-operative EEG monitoring, seizure detection is frequently mentioned. The preliminary results from this study suggest that seizures can be detected using the processed EEG and in our controlled setting have characteristic appearances, depending on the monitor used. Our patients were paralyzed, and muscle artifact in the unparalyzed patient with seizures would predictably introduce artifact into the EEG and alter the appearance on the displays. Other seizures (ex. petit mal) have characteristically different appearances on the raw EEG, and thus may appear differently using processed EEG. Thus, caution must be used in interpretation of EEG when relying on the processed waveform, and reference to the raw EEG (an available feature on all of these devices) is strongly recommended.

References:

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2. Smith WD: Walsh versus Fourier estimators of the EEG power spectrum. IEEE Transactions Biomed Engn: BME-28; 790-793, 1981