Interobserver variability of EEG in comatose patients


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Three-dimensional topography mapping program of brain electrical activity on personal computer

Fumihiko Suzuki 1, Shigeki Tani 2, Kyoichi Oohashi 3. 1 First Department of Medicine, Hamamatsu University School of Medicine, Japan; 2 Department of Medical Informatics, Hamamatsu University School of Medicine, Japan; 3 Department of Clinical Pharmacology, Hamamatsu University School of Medicine, Japan

Topographic mapping of the brain electrical activity such as evoked potentials or frequency spectrum of electroencephalogram (EEG) has been studied since 1970's. A large-sized computer was required to generate even a two-dimensional (2D) topographic map in the beginning of studies. However, today's personal computer has an enough performance to generate three-dimensional (3D) topographic maps. We made software on IBM PC/AT compatible personal computer for research of brain electrical activity. The system functions of this software are as follows. (1) Raw EEG data acquisition from a preamplifier (maximum 32 channels at the fastest sampling frequency of 2000 Hz). (2) Raw data selection, averaging, digital filtering and calculation of frequency spectrum using fast Fourier transform (FFT). (3) Generation of 2D and 3D topographic maps. (4) 2D and 3D moving topography. Conventional 2D topographic maps have contortion of graphical representation, because the spherical scalp surface is deployed into a round shape. On the other hand, 3D topographic maps show stereoscopic and undistorted graphical representation, which help to understand actual 3D configuration of the scalp electrical fields. Anyone can use and spread this software freely.

Potential flow of alpha activity during music listening

Kazuhiro Shinosaki, Tsuyoshi Inouye, Seigo Tobi, Yuko Matsumoto, Naoki Hosaka, Ryobei Ishii. Department of Psychiatry, Osaka University Medical School

The movement of potential fields of alpha activity during music listening was studied with a detection technique of potential flow. EEGs during both music listening and resting were recorded from 32 electrode locations in 15 normal subjects. Artifact-free EEGs were digitized at a sampling interval of 5 msec for 30 sec, and were band-pass filtered into slow and fast alpha subbands. The potential mapping for each subband was constructed on a frame with interpolation at each successive sampling interval. The frame consisted of a square grid of 21 x 21 points. The x- and y-components of potential flow vector were calculated over 6000 consecutive frames with a gradient method, and were averaged across frames. Significant differences in the vectors of slow alpha between the 2 conditions were found over the mid- and right central and the right post-temporal regions (Hotelling T^2 test, p < 0.05). No significant vector differences, however, were found for fast alpha. These findings suggested that the right post-temporal region was activated during music listening, and that the central region was possibly related to attentive performance.

EEG findings for drivers during driving in a highway

Z. Shiozawa 1, A. Amino 1, T. Nagaoka 1, K. Shindo 1, H. Nagaoka 2, T. Kobayashi 3, K. Mihara 4, T. Mano 5. 1 Third Department of Internal Medicine, Neurology, 2 Second Department of Physiology, Yamanashi Medical College, Ashikaga Industry University, Ashikaga; 3 Navitech Company, Iida, and Nagoya University, Nagoya, Japan

Purpose: It has not been resolved how are the driver's physical conditions when driving a car in a highway. Although sleepiness for drivers during driving seems to be one of the important causative factors for car accidents, there are few reports studied on sleepiness for drivers.

Method & Subjects: We recorded scalp EEG, eye movements and mental muscle EMG using multi-purpose EEG apparatus for 15 healthy men with more than 20 years-old ages, in a private car throughout long distance highway drives, at least more than 2 hours in a daytime and also in night time.

Results: EEG findings for drivers during long distance highway drives show initially beta activities. As the time goes on, (1) blinkings of eye-lids increase, (2) diffuse slower alpha activity appears when drivers close their eye lids, (3) continuous theta activities persist, and (4) sometimes sleep spindle appears. These findings are severe when drivers complain of sleepiness, but they are recognized even when drivers do not complain of any sleepiness. On electrical stimulation for drivers, their EEG activities tend to return back to beta activities.

Conclusion: It is worth recognizing that drivers can drive a car with sleepiness or even without sleepiness when EEG shows sleep patterns during a long distance highway driving.

Computer analysis of 24-hours EEG pattern in preterm infants

Pan Xiao Li, Teruyuki Ogawa, Keisuke Sato. Dept. of Pediatrics, Oita Medical University, Oita, Japan

The study about active sleep before (ASb) and after (ASa) quiet sleep EEGs was acquired by computerized monitoring system. The continuous EEG (Fpl-C3) recordings were made over a period of 24-hours in 2 preterm infants (CA: 34w6d, 37w1d, respectively). The results showed: the values of total power (TP) in ASb were higher than those in ASa in both of preterm infants (unpaired t-test: P < 0.01), these coincided with the 'low-voltage' EEG pattern in ASb. But the significant differences of Akaike information criterion (AIC), total bioinformation amount (TI), damping frequency (FD), bioinformation amount (I), power (P) and damping time / time constant (DT/TC) between ASb and ASa were not observed. The small sample size prevents us from making a final conclusion about the quantification EEG pattern in preterm infants.

Interobserver variability of EEG in comatose patients

P.C.G. Nijssen 1, R.L.L.A. Schellens 2, C.C. Tijsen 1, A.A.W. Op de Coul 1, A.C.M. Leyten 1, F.H. Lopes da Silva 3, 1 Department of Neurology, St Elisabeth Hospital, Tilburg; 2 Department of Experimental Zoology, Biology Center, University of Amsterdam

Electroencephalography may be a valuable tool in the analysis of...
comatose patients. Although EEG patterns in coma are often non-specific and have limited prognostic value, visual EEG analysis is widely used. However, interobserver reliability of visual EEG analysis has received little attention. We prospectively studied 90 EEGs of 29 patients with an initial Glasgow coma score of 8 or less, in different disease categories (13 cranioencebral trauma, 3 cerebral hematomas, 2 subarachnoid hemorrhages, 5 posthypoxic encephalopathy, 2 meningitis, 1 status epilepticus, 1 basilar artery thrombosis). EEGs were recorded at the day of inclusion (day 1), day 3, day 7 and day 30. The EEGs were independently analyzed by 5 neurologists (4 experienced, 1 novice), using the definitions of the Rae-Grant dichotomous rating scale. Interobserver agreement beyond chance (kappa) was good for burst suppression (mean K 0.72, range 0.52–1), electrocerebral inactivity (mean K 0.68, range 0.55–0.88), epileptic activity (mean K 0.72, range 0.49–0.92), delta (mean K 0.53, range 0.43–0.75) and low voltage EEG (mean K 0.56, range 0.39–0.75); fair for alpha rhythm, beta, theta, theta coma, focal delta, asymmetry, spindles, posterior suppression, IRDA, trip basic waves (mean K between 0.2 and 0.5). Poor kappa values were found for variability, abnormal spindles and episodic low amplitude events. Fortunately, the items with poor agreement have restricted influence on the dichotomous rating scale. A Pearson correlation of 0.597 (p < 0.000) was found for the Hockaday score vs. dichotomous score. These results indicate that interobserver agreement for most EEG parameters in comatose patients is substantial to good, especially for the parameters with high prognostic value.

**PS-26-9**

Spatio-temporal entropy and dimension of normal and pathological EEG

Vlada Radivojević¹, Milan Rajković², Dejan Timotijević³, Marko Car¹.¹ Institute for Mental Health, Department of Clinical Neurophysiology; ² The Institute of Nuclear Sciences VINCA, Institute of Physics, Belgrade, Yugoslavia

A novel method of EEG analysis based on theory of deterministic chaos was used for description of spatial and temporal patterns of brain electrical field. This method combines nonlinear dynamics theory, signal processing and information theory in estimating EEG entropy and dimension as measures of signal complexity which vary in space and time. The analysis was performed for each hemisphere as a whole and for separate anatomical regions, for normal EEGs and pathological cases of focal and generalized interictal and ictal activity. We showed that values of entropy and dimension of normal EEGs clearly differed from pathological ones and that pathological EEG patterns could be accurately spotted in space and time. Furthermore, we showed that these values appreciably change some time before the epileptiform discharge, i.e. during the period of apparently normal EEG trace when visual inspection and classical method of frequency analysis by Fast Fourier Transform gave no useful information. We believe that advantage of this method is its ability to reveal deterministic structure in EEG, as opposed to stochastic measures such as frequency spectrum, and hence that it is more sensitive and specific for EEG changes. Since this method could be applied to a data set as small as fraction of second of digitized EEG signal, and since it uses highly optimized numerical algorithm, results could be obtained practically on-line with EEG recording (continuous real-time analysis) in clinical or research settings.

**PS-26-10**

Electroencephalogram findings in mitochondrial encephalomyopathy

Xiuqin Liu, Yupu Guo, Zhong Guo. Department of Neurology, Peking Union Medical College Hospital, P.R. China

Eight patients with mitochondrial encephalomyopathy were reported, six with mitochondrial myopathy, encephalopathy, acidosis, and stroke like episodes (MELAS), two with the Kearns-Sayre syndrome (KSS). Three were members of the same Pedigree.

All showed abnormal electroencephalogram (EEG) except one patient with KSS. Another KSS EEG had posterior slowing. Six with MELAS EEGs showed marked abnormalities. The manifestations of EEG included: (1) diffuse slowing in different degree with or without increased focal slowing in 5 cases (2) generalized paroxysmal activities including spike, or/and sharp waves in 3 cases. (3) paroxysmal focal spike or/and sharp waves in 2 cases. (4) photic stimulation activated generalized paroxysmal spike, sharp and slow wave in 2 cases. The severity of EEG abnormality in 2 patients with KSS was less than patients with MELAS. Although these findings were nonspecific, paroxysmal abnormalities in base of diffuse slowing were often suggestive of existence of diffuse cerebral lesions, and remind the doctors to research the cause of the illness.

**PS-27. DEMENTIA AND RELATED DISORDERS**

**PS-27-1**

Fluctuation analysis of EEG in dementia

Ryuya Yanagihashi¹, Takayuki Fujiwara¹, Mitsuhiro Ohkura², Yoshihisa Ohhara¹.¹ School of Allied Medical Sciences, Shinsyu University; ² Kochi Rehabilitation Institute; ³ Seiwa Hospital

Fluctuation analysis of alpha-wave in EEG was investigated in order to characterize the brain function in Dementia. Six CVA patients with mild dementia (aged 61–85 years) were studied after obtaining the informed consent. After recording EEG for 6 min in a normal oxygen level (20.9% of oxygen), subjects were put for 30 min in a normobaric hyperoxic prefabricated chamber (30.0% of oxygen) and EEG in a hyperoxia level was recorded for 6 min from five cortical sites by the international 10–20 method (F3, F4, Cz, P3, P4). These EEGs were A/D converted and passed through a digital band-pass filter with an alpha band (8–13 Hz) by PC-9801 personal computer after amplifying and recording to digital audio tapes. Bio-information multi-task analyzing program (BIMUTAS-E Ver. 2.15, KISSEI COMTEC) was used as a signal processing software. Time-dependent fluctuation in the frequency of alpha wave of EEG were produced by the zero-cross method, and power spectra of these fluctuation waves were computed using the fast Fourier algorithm. These power spectra were described on log scales. So these logarithmic graphs could be approximately expressed by linear equations, we approximated straight lines and calculated their slope values. The mean value of the slope of regression lines obtained from the spectrum of EEG in the hyperoxic chamber was lower than in control. These results suggest that an acute oxygen exposure activates the excitation of the cortical neurons in the demented patients and that promote their certain brain activities.