Relationship between EEG reactivity and neuropsychological tests in vascular dementia

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Summary. 17 patients with vascular dementia (VaD) representing moderate to severe stage of the disease and 11 age-matched control subjects were examined with spectral analysis of EEG and a neuropsychological test battery comprising visual, praxic, verbal and memory functions as well as Mini-Mental Status test. VaD patients did not have less activity in the alpha band than control subjects, but the alpha amplitude ratio between eyes closed (EC) and eyes open (EO) situations (EC/EO ratio) was decreased in VaD patients, compared to controls. In VaD the variables of the awake background EEG with eyes closed (amplitude of alpha, beta, theta and delta activity; mean frequency) had only a few correlations to neuropsychological test scores. However, the (EC) / (EO) alpha ratio showed significant correlations with several neuropsychological variables in the temporo-occipital and centro-parietal derivations and some of these correlations were lateralized to the left or right hemisphere. Frontal EEG derivations with less alpha activity did not reveal any correlations to neuropsychological variables. We conclude that the dynamic EC/EO alpha ratio variable may be even more sensitive in the assessment of brain dysfunction in VaD than the background EEG variables.

Keywords: Vascular dementia, EEG, cognition, neuropsychology

Introduction

Vascular dementia (VaD) and Alzheimer’s disease (AD) are the most common causes of dementia in old age in Western countries (Selkoe, 1992). EEG in VaD shows a different picture of deterioration than that of AD: in VaD there are sudden EEG changes with frequent asymmetries and slowing (Soininen et al., 1982) but EEG often ameliorates before the next stroke. In AD the deterioration of EEG is more gradual (Rae-Grant et al., 1987; Soininen et al., 1989). In Alzheimer’s disease severity of dementia parallels the cognitive decline and quantitative EEG variables have shown to correlate
with distinct neuropsychological deficits (Helkala et al., 1991). Moreover, the relationship of impaired cortical functions and the slowing of EEG activity is characteristic for dementia of Alzheimer’s disease but not in demented patients with Parkinson’s disease (Helkala et al., 1991). The aim of this work was to find the possible correlations of neuropsychological variables to EEG in VaD. Both background EEG variables (Penttilä et al., 1985) and a dynamic alpha variable, alpha amplitude ratio between eyes closed (EC) and eyes open (EO) situations (Könönen and Partanen, 1993) was tested in the correlation analysis.

Material and methods

We studied 17 VaD patients (13 female and 4 male, age 64–90 years, mean 81 years) and 11 controls (9 female and 2 male, age 69–96 years, mean 82 years). The patients were hospitalized in the geriatric departments of their local hospitals. The VaD diagnosis was based on DSM-III-R (American Psychiatric Association, 1987) and the ischemic score (mean 7.7) (Rosen et al., 1980). The patients suffered from moderate or severe stage of the disease. Two of them had atrial fibrillation, 5 cardiac insufficiency, 9 transient ischaemic attacks (TIA) and all but two clinical symptoms of stroke. Eight of them were diabetic. Two of the patients received anticonvulsive, four benzodiazepine, two antidepressive and eight neuroleptic medication in small doses. Of these patients one received benzodiazepine and neuroleptic and two neuroleptic and antidepressive medication and the total number of patients receiving psychotropic medication was ten. None of the patients were taking other drugs known to interfere with the EEG (Glaze, 1990). The controls were healthy elderly people living in an old age home with neither history nor signs of any neurological disease. The patients and control subjects underwent the following evaluation: medical history, examination of medical records, clinical neurological examination, Mini-Mental Status examination (Folstein et al., 1975), activities of daily living assessed by the scale of Blessed (Blessed et al., 1968), modified ischemic score (Rosen et al., 1980) neuropsychological evaluation and EEG. The study was approved by the local ethics committee and informed consent was obtained from the patient or a near relative as well as the control subjects.

EEG methods

Conventional EEG recordings were performed with a 10-channel Siemens Mingograph apparatus, using the international 10/20 system and Ag/AgCl-electrodes with a bandpass set at 0.5 to 70 Hz. For quantitative analysis of EEG (QEEG) the recording was performed from derivations T6-O2, T5-O1, C4-P4, C3-P3, F4-C4, F3-C3. An additional channel was used to monitor eye movements (below the left lower lid to a site just laterally from the orbita) and their possible synchronous reflections in EEG channels. The recording was at first performed in relaxed awake stage with eyes closed (EC) and thereafter a second EEG sample was collected with eyes open (EO) to analyse the visual performance in EEG (EC/EO ratio; Könönen and Partanen, 1993). The EEG was digitized at 125 samples/sec with a 12-bit A/D converter (HP 9864A). Four epochs of 8.192 sec were recorded. The epochs were visually monitored on the Hewlett Packard 310 computer screen. Samples with distinct eye movement or muscle artifacts were manually rejected by the EEG technician, and a new epoch was collected. The final EEG sample (4 × 1024 points) was stored on a disc for off-line analysis.

The Fast Fourier transformation (FFT) was computed on a series of 12 half-overlapping sections corresponding to a discontinuous EEG signal of the total length of 32.772 sec. To reduce leakage and time truncation errors, the time domain wave form of each section was multiplied by a cosine (Hanning) window before the FFT operation. The absolute amplitude of the delta (1.46–3.91 Hz), theta (4.15–7.32 Hz), alpha (7.57–