Discrimination of stroke-related mild cognitive impairment and vascular dementia using EEG signal analysis

ABSTRACT

Stroke survivors are more prone to developing cognitive impairment and dementia. Dementia detection is a challenge for supporting personalized healthcare. This study analyzes the electroencephalogram (EEG) background activity of 5 vascular dementia (VaD) patients, 15 stroke-related patients with mild cognitive impairment (MCI), and 15 control healthy subjects during a working memory (WM) task. The objective of this study is twofold. First, it aims to enhance the discrimination of VaD, stroke-related MCI patients, and control subjects using fuzzy neighborhood preserving analysis with QR-decomposition (FNPAQR); second, it aims to extract and investigate the spectral features that characterize the post-stroke dementia patients compared to the control subjects. Nineteen channels were recorded and analyzed using the independent component analysis and wavelet analysis (ICA−WT) denoising technique. Using ANOVA, linear spectral power including relative powers (*RP*) and power ratio were calculated to test whether the EEG dominant frequencies were slowed down in VaD and stroke-related MCI patients. Non-linear features including permutation entropy (PerEn) and fractal dimension (FD) were used to test the degree of irregularity and complexity, which was significantly lower in patients with VaD and stroke-related MCI than that in control subjects (ANOVA; $p < 0.05$). This study is the first to use fuzzy neighborhood preserving analysis with QR-decomposition (FNPAQR) dimensionality reduction technique with EEG background activity of dementia patients. The impairment of post-stroke patients was detected using support vector machine (SVM) and *k*-nearest neighbors (*k*NN) classifiers. A comparative study has been performed to check the effectiveness of using FNPAQR dimensionality reduction technique with the SVM and *k*NN classifiers. FNPAQR with SVM and *k*NN obtained 91.48 and 89.63% accuracy, respectively, whereas without using the FNPAQR exhibited 70 and 67.78% accuracy for SVM and *k*NN, respectively, in classifying VaD, stroke-related MCI, and control patients, respectively. Therefore, EEG could be a reliable index for inspecting concise markers that are sensitive to VaD and stroke-related MCI patients compared to control healthy subjects.

Keyword: Electroencephalography; ICA−WT; Relative power; Permutation entropy; Fractal dimension; Vascular dementia; Mild cognitive impairment