5th International Conference of Cognitive Science
7-9 May 2013
Tehran
ICCS 2013

Spectral Analysis of Purkinje Cell Output

Samira Abbasi*[1], Ataollah Abbasi[1], Yashar Sarbaz[2]

1. Department of Biomedical Engineering, Faculty of Electrical Engineering, Sahand University of Technology, Tabriz, Iran

2. Department of Emerging Technology, School of Engineering, University of Tabriz, Tabriz, Iran

Introduction: Purkinje cells constitute the sole output cell of the cerebellar cortex. Electrophysiological dysfunction of Purkinje cells can lead to cerebellar ataxia. Previous studies have proposed a spectral model of the normal Purkinje cell output, as a combination of three inherent frequencies observed in its spectrum. These frequencies are due to the sodium and calcium spikes and the cells' switching behavior (between quiescence and firing modes). Hence, we also investigated the spectral model of the firing activity of normal and ataxic Purkinje neurons to evaluate differences in power spectral density and in order to analyze changes in the intrinsic properties due to cerebellar ataxia.

Methods: The current study used cell output data from 15 and 18 normal and ataxic Purkinje cells (data published by Janahmadi et al.). To identify frequency components of Purkinje cell output, the power spectral density (PSD) of each 60s recorded signal was computed. Based on a spectral model of Purkinje cell behavior, frequencies of the peaks were collected for the spectrum of all the cells and used to compare cells' electrophysiological behavior and demonstrate electrophysiological changes in ataxic Purkinje cells.

Results: The three characteristic frequencies – sodium, calcium and switching, of normal Purkinje cells (expressed in mean ± standard deviation) occur in mean frequencies of 52.18±15.69, 14.74±9.61, and 0.35±0.22Hz, respectively. In cerebellar ataxia conditions, these frequencies change to 58.49±26.75, 5.43±3.17 and 0.5 ±0.37 Hz, respectively.

Conclusion: We examined fundamental frequencies of normal and ataxic Purkinje cells. Power spectra of normal and ataxic Purkinje cell outputs were computed using signal processing analysis. Our study found a significant difference in frequency components of normal and ataxia groups. Specifically, evaluation of power spectra in the two groups showed significant differences in the main peak of switching and calcium bands. Switching and calcium frequencies were significantly higher and lower, respectively, in ataxia group while sodium frequency change in ataxia group was not remarkable. This study proposes that a significant change in cerebellar ataxia is related to the calcium band. The proposed analysis can be used to help clinicians diagnose ataxia and this difference may be a good feature to discriminate of these two groups.

*Corresponding author. E-mail address: samira.abbasi@gmail.com