

Extraction of typical features from surface EMG signals in Parkinson's disease

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Objective: The aim of this study was to develop and test different mathematical methods for extraction of typical features from surface electromyographic (EMG) signals in Parkinson's disease (PD).

Background: Surface EMG measurements and analysis are mainly used to examine level of muscle activation and fatigue. Conventional methods of surface EMG analysis are amplitude and spectral analysis. However, in the case of Parkinson's disease, more novel methods are needed to analyse the detailed structure of EMG signal. The main changes in the EMG signal caused by PD are increased tonic background activity and an alternating pattern of EMG bursts. The increased background activity can be seen as increased amplitude of the signal but the characterization of the burst-like activity of EMG requires methods that are sensitive in detecting 1) the distribution of the signal values and 2) the recurrences of the signal values in time domain.

Methods: The methods of EMG analysis used in this study were specifically chosen and developed based on their potential suitability for characterizing Parkinsonian EMG signals. The used methods involved novel structural (histogram and crossing rate distribution based) methods and nonlinear (entropies, fractal analysis, recurrence quantification analysis) methods. All algorithms for the data analysis were programmed by MatlabTM. For the extraction of typical features from Parkinsonian EMGs, principal component analysis was used. The methods were tested with EMG data measured from patients with PD and healthy controls.

Results: Results of the analysis showed that the structural and nonlinear methods were suitable methods for characterizing Parkinsonian EMG signals. By using structural methods the burst-like activity of EMG could be seen as a change in the shape of the histogram and crossing rate distribution. Reduced complexity and increased recurrence of Parkinsonian EMG, instead, were revealed by nonlinear methods of EMG analysis.

Conclusions: Structural and nonlinear methods of EMG analysis are potential methods for extracting typical PD related bursting features from EMG signals. These methods form a promising approach for the surface EMG analysis in Parkinson's disease. Further studies regarding their diagnostic value are suggested.