Classification of type-2 diabetes vs. healthy volunteers using features extracted from cerebral hemodynamic signals

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Introduction: Cerebral hemodynamics in type-2 diabetes mellitus (T2DM) are considered to be impaired possibly due to endothelial dysfunction. Findings regarding perfusion have been inconsistent potentially reflecting differences between the perfusion imaging techniques as well as pathological diversity. In this study we have used multi-inversion timepoint ASL to examine hemodynamic changes in the diabetic brain. We focused on three hemodynamic curves obtained using quantitative STAR labeling of arterial regions (QUASAR) ASL [1]. Multiple curve-descriptive metrics were extracted. Subsequently dimensionality reduction was implemented to maintain the most significant feature combination and attempt subsequent classification.

Methods: Data were acquired from 22 HV (42±16yrs) and 16 subjects with T2DM (54±11yrs) at 3T (Achieva, Philips, NL). In house developed software was used for QUASAR data analysis. Two QUASAR scans were acquired; one at baseline and one following acetazolamide (vasodilator) injection. The three quantified curves in every voxel were: arterial input function, residue function, and the tissue curve. Data were extracted from whole brain and from four ROIs adjacent to: anterior cerebral artery (ACA), middle cerebral artery (MCA), posterior cerebral artery (PCA) regions and watershed areas (W). The time-to-peak, peak, full-width half maximum, skewness, kurtosis, half width half maximum left and right were determined from each ROI for all curves. T-tests were used to keep the significant features ($p < 0.05$); subsequent support vector machine recursive feature elimination (SVM-RFE) [2] was implemented in order to retain the most influential features. Features scoring in the top-5 in the SVM-RFE task were kept each time and used for classification, conducted using linear-SVM with 5-cross cross validation.

Results: Overall 206 features were considered. 97 of them were significantly different (t-tests) between the groups. Following SVM-RFE 16 features comprised the evaluated pattern. The classifier's performance was 92%.

Discussion and Conclusions: It has been shown that extraction of multiple metrics from hemodynamic curves acquired with QUASAR ASL can provide information pertaining to the differentiation between HV and T2DM patients. The classification accuracy was high, suggesting that the extracted perfusion pattern can capture hemodynamic differences between the groups. The same pipeline could be used to examine in depth cerebral hemodynamics in other diseases (e.g. Alzheimer's) affecting cerebral perfusion.

References

1. Petersen, E.T., T. Lim, and X. Golay, *Model-free arterial spin labeling quantification approach for perfusion MRI.* Magnetic Resonance in Medicine, 2006. **55**(2): p. 219-232.
2. Guyon, I., et al., *Gene Selection for Cancer Classification using Support Vector Machines.* Machine Learning, 2002. **46**(1-3): p. 389-422.