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Patient-specific detection of perfusion abnormalities combining within-subject and between-subject variances in Arterial Spin Labeling

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Abstract

In this paper, patient-specific perfusion abnormalities in Arterial Spin Labeling (ASL) were identified by comparing a single patient to a group of healthy controls using a mixed-effect hierarchical General Linear Model (GLM). Two approaches are currently in use to solve hierarchical GLMs: (1) the homoscedastic approach assumes homogeneous variances across subjects and (2) the heteroscedastic approach is theoretically more efficient in the presence of heterogeneous variances but algorithmically more demanding. In practice, in functional magnetic resonance imaging studies, the superiority of the heteroscedastic approach is still under debate. Due to the low signal-to-noise ratio of ASL sequences, within-subject variances have a significant impact on the estimated perfusion maps and the heteroscedastic model might be better suited in this context.

In this paper we studied how the homoscedastic and heteroscedastic approaches behave in terms of specificity and sensitivity in the detection of patient-specific ASL perfusion abnormalities. Validation was undertaken on a dataset of 25 patients diagnosed with brain tumors and 36 healthy volunteers. We showed evidence of heterogeneous within-subject variances in ASL and pointed out an increased false positive rate of the homoscedastic model. In the detection of patient-specific brain perfusion abnormalities with ASL, modeling heterogeneous variances increases the sensitivity at the same specificity level.

Keywords: Arterial Spin Labeling, Hypo-perfusion, Hyper-perfusion, General Linear

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