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Glucose metabolism-weighted imaging with chemical exchange-sensitive MRI of 2-deoxyglucose (2DG) in brain: sensitivity and biological sources

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Abstract

Recent proof-of-principle studies have demonstrated the feasibility of measuring the uptake and metabolism of non-labelled 2-deoxy-D-glucose (2DG) by a chemical exchange-sensitive spin-lock (CESL) MRI approach. In order to gain better understanding of this new approach, we performed dynamic *in vivo* CESL MRI on healthy rat brains with an intravenous injection of 2DG under various conditions at 9.4 T. For three 2DG doses of 0.25, 0.5 and 1 g/kg, we found that 2DG-CESL signals increased linearly with injection dose at the initial (<20 min) but not the later period (>40 min) suggesting time-dependent differential weightings of 2DG transport and metabolism. Remaining 2DG-CESL studies were performed with 0.25 g/kg 2DG. Since a higher isoflurane level reduces glucose metabolism and increases blood flow, 2DG-CESL was measured under 0.5%, 1.5% and 2.2% isoflurane. The 2DG-CESL signal was reduced at higher isoflurane levels correlating well with the 2DG phosphorylation in the intracellular space. To detect regional heterogeneities of glucose metabolism, 2DG-CESL with 0.33×0.33×1.50 mm^3 resolution was obtained, which indeed showed a higher response in the cortex compared to the corpus callosum. Lastly, unlike CESL MRI with the injection of non-transportable mannitol, the 2DG-CESL response decreased with an increased spin-lock pulse power confirming that 2DG-CESL is dominated by chemical exchange processes in the extravascular space. Taken together,