13C NMR for the assessment of human brain glucose metabolism in vivo

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Proton-decoupled 13C NMR spectra of the human head were obtained during hyperglycemic glucose clamping using intravenous infusions of [1-13C]glucose in normal volunteers. In addition to 13C signals of mobile lipids, a variety of new metabolite resonances could be resolved for the first time in the human brain. At an enrichment level of 20% [1-13C]glucose, the signals of alpha- and beta-glucose at 92.7 and 96.6 ppm, respectively, could be detected in the human brain after only an infusion period of 15 min. The spatial localization of the different regions of interest was confirmed by 13C NMR spectroscopic imaging with a time resolution of 9 min. Increasing the enrichment level to 99% [1-13C]glucose not only improved the time resolution but allowed the detection of metabolic breakdown products of [1-13C]glucose. The time course of 13C label incorporation into the C2, C3, and C4 resonances of glutamate/glutamine and into lactate could be recorded in the human brain. These results suggest the possibility of obtaining time-resolved, spatially selective, and chemically specific information on the human body.
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