

Increased Astroglial Metabolism during Postnatal Development in Rat Brain

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INTRODUCTION: There is a rapid increase in the number of neuronal cells and synapse formation in the brain during postnatal development. The period between the first and third postnatal week in rodents is a critical period in development of brain. Glutamatergic and GABAergic neurons undergo large increases in oxidative energy metabolism and neurotransmitter cycling during this major postnatal growth spurt¹. However, little or no information is available regarding the role of astroglia in brain development. The objective of current study was to evaluate the astroglial metabolism in rat cerebral cortex during postnatal development by using ¹H-[¹³C]-NMR spectroscopy together with infusion of [2-¹³C]acetate.

MATERIALS AND METHODS: All experiments were performed under protocols approved by the Institute Animal Ethics Committee. Male SD rats were studied at two postnatal ages: P10 (n=11) and P30 (n=9). For metabolic studies, urethane anesthetized rats were infused with [2-¹³C]acetate² (via tail vein for P10 and femoral vein for P30 rat) for 10 min and 2 h. At the end of the experiment, brain was frozen *in situ* in liquid N₂ and metabolites were extracted from frozen cortical tissue³. ¹H-[¹³C]-NMR spectra were acquired from cortical extract at 600 MHz NMR spectrometer (Bruker Avance II) for the measurement of concentration and ¹³C enrichment of amino acids⁴. Concentration and Percent ¹³C enrichment of plasma acetate was measured in ¹H NMR spectrum.

RESULTS AND DISCUSSION: Level of Glutamate, GABA, glutamine, aspartate, NAA, m-inositol and creatine was found to be increased significantly (p<0.01) while level of taurine was found to be reduced significantly in the cerebral cortex (Fig. 1A). The percent ¹³C enrichment of Gln_{C4} from [2-¹³C]acetate in 10 min was increased significantly in P30 rats. This together with no change in the steady state labeling of Gln_{C4} indicates an increase in astroglial activity from P10 to P30. Nonlinear least-squares fitting to the labeling of Gln_{C4} (Fig. 1B) to a mono-exponential function indicated three folds increase in acetate utilization at P30 (P10 = 0.045±0.005 μmol/g/min and P30 = 0.146±0.04 μmol/g/min). To the best of our knowledge, this is the first study reporting increased astroglial metabolism hence glial activity during postnatal development period in rat brain.

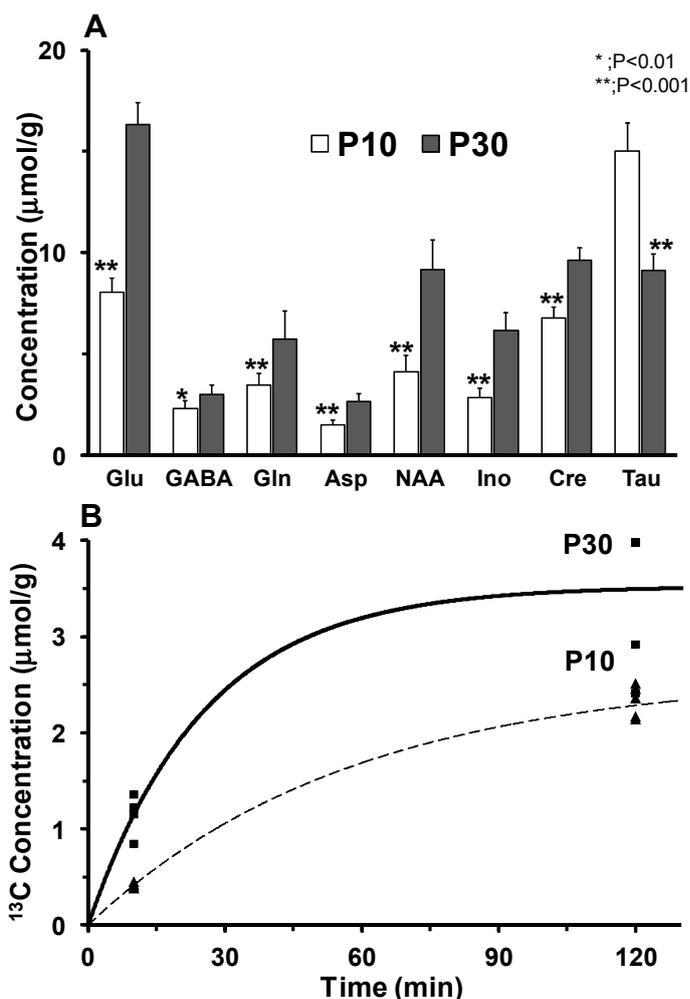


Fig. 1. A: Concentration of metabolites; **B:** Monoexponential fitting to amino acid labeling from [2-¹³C]acetate at P10 & P30

References: 1. McIlwain and Bachelard (1985), *Biochemistry and The Central Nervous System*; 2. Patel et al (2005) *Proc Natl Acad Sci USA* **102**:5588; 3. Patel et al (2001) *Brain Res* **919**:207; 4. de Graaf et al (2003) *Magn Reson Med* **49**:37.

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