BOLD IMAGING OF ADULTS AND INFANTS UNDER HYPOXIA AND HYPEROXIA

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Introduction:

Oxygenation of blood changes due to pathology, and to a lesser extent, due to normal variability. Maintaining cerebral perfusion is critical, particularly in neonatal patients. We present preliminary data of cerebral blood oxygenation dependent signal changes due to hypoxia and hyperoxia manipulations in healthy adults and a neonate scanned at term-equivalent age.

Methods:

Two healthy adults and one neonate (scanned at term-equivalent age, being discharged), were examined. All studies were performed on a clinical 3.0T MR scanner (Philips, Achieva, Best, The Netherlands). Blood oxygenation level dependent MRI (BOLD) with TR=3000 TE=5, Acq. Matrix 72x70, 32 Slices, was performed throughout the manipulations. Images were transferred to an off-line computer for processing.

In the adults the fraction of inspired oxygen (FiO2) was modulated by adjusting delivery to a non-rebreathing circuit from three compressed reservoirs: room air (79 O2:21 N2), high nitrogen (88 O2:12 N2), and oxygen (100 O2). The neonatal patient was intubated, allowing the adjustment of the oxygen flow to desired level. In this preliminary survey, BOLD signal changes of the whole brain in response to changes of FiO2 were determined. Exponential curves ($s=a-b\cdot\exp(-t/tau)$) were used to parameterize the rate of change following FiO2 manipulations.

Results:

Manipulation of FiO2 resulted in readily detectable changes of signal amplitudes in BOLD images as illustrated in Fig. 1+2. In both hypoxia studies, A (adult) & B (neonate), decreased FiO2 caused a rapid decrease in signal. The adult decline (tau=31.68 s^{-1}) was more rapid than the neonate decline (tau=43.39 s^{-1}). The adult recovery (tau=38.41 s^{-1}) was markedly more rapid than the neonate recovery. (tau=106.4 s^{-1}).

In the hyperoxia study C1 and C2 (adult) the increased FiO2 caused a rapid increase in signal. Note that C1 and C2 were run sequentially. The adult rise (tau=43.81 s^{-1}) and recovery (tau=28.72 s^{-1}) were both similar to the adult hypoxia time constants. Neonatal, BOLD (left) and BOLD difference (right) images are shown. The difference image was computed between the start and end of the hypoxia.

Discussion:

Blood oxygenation of neonates is of particular interest due to the clinical interventions that are used in the newborn and infant critical care unit. Physicians attempt a variety of respiratory therapies designed to maintain adequate cerebral oxygenation, but apply these therapies without a full understanding of how they affect the cerebral oxygenation. Our preliminary data indicate that there are substantial differences between the neonatal brain and adult brain when reacting to oxygen manipulations. Additional studies performed in the above subjects using arterial-spin-labeling (not discussed in this abstract) require further consideration when reviewing the BOLD data.

Fig. 1

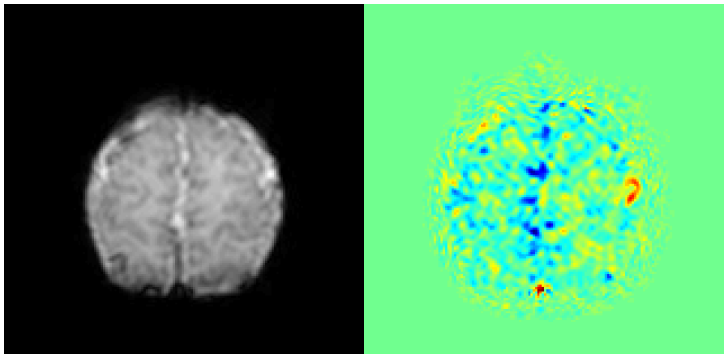

Fig. 2