DTI Evidence of Persistence of the Ventricular Zone in Human Preterm Infants

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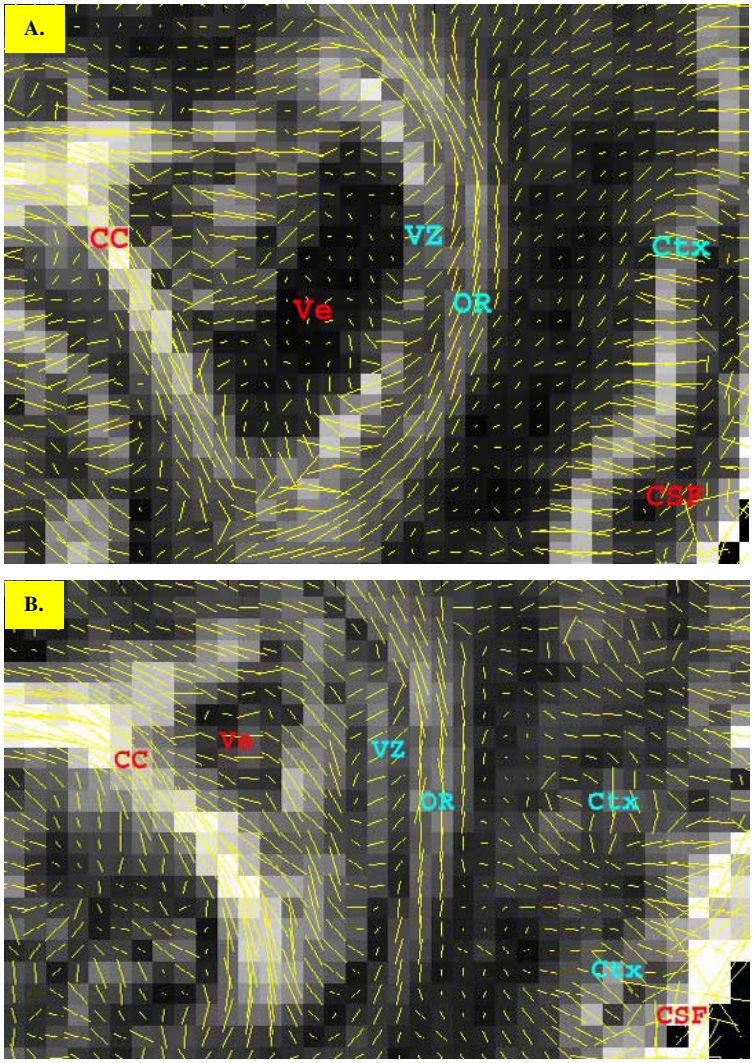
Introduction: DTI provides detailed information regarding tissue microstructure. In the developing human brain, significant changes in both size and structure occur in the ventricular zone. These changes are due to the developmentally time-locked events of neuronal proliferation and migration. Neuronal migration is typically complete by 26 weeks gestation in humans [1]. At this time, the radial glia fibers that impart the strong radial orientation of this zone are diminishing or are no longer present. Previous studies of neonatal brain (both *in vivo* and *ex vivo*) and have shown disappearance of this zone by 20weeks gestation by DTI and by 26-30 weeks via histochemistry [1-3]. There has been significant recent interest in this zone as a source of pluripotent neural stem cells. Recent studies have shown both expansion in size and reemergence of the radial organization of this zone in response to hypoxic-ischemic injury in an immature rat and in the prematurely delivered baboon [4, 5]. Based on these data, we postulated that preterm human infants would have evidence of retained ventricular zone and anisotropy detectable by DTI.



Methods: Four human preterm infants ranging from 27 to 33 weeks gestational age were enrolled in a longitudinal cohort study relating magnetic resonance imaging (MRI) and clinical outcome. The study was approved by the Institutional Review Board of the Medical School. DTI was obtained on 3.0-T Siemens Trio scanner using a single shot echo planar imaging sequence with TR 13300 ms, TE 112 ms, spatial resolution 1.2 – 1.5mm isotropic, and 48 b-values (ranging 0 s/mm^2 to 1200 s/mm^2 with independent directions). Raw data were processed using in-house software that included phasing, image alignment, outlier detection, and estimation of DTI parameters using a probability theory based algorithm (Levenberg-Marquardt). Euler angle estimates were used to compute whiskers representing the major eigenvector orientation and displayed using Matlab.

Results: Figure 1 shows RA maps with whiskers overlaid from different infants at A) 29 and B) 33 weeks. Note high anisotropy in the ventricular zone (VZ) comparable to the optic radiation (OR). Note also the radial orientation of the whiskers in both the ventricular zone and cortex (Ctx). Anatomic structures labeled include ventricle (Ve), corpus callosum (CC), and CSF.

Discussion: We have shown evidence for persistence of the ventricular zone in human preterm infants at a time when it is expected to be significantly diminished or absent and without strong radial orientation. It is not clear from this study whether this represents a delay in maturation or a response to injury. The hypothesis that persistence of the ventricular zone is a response to injury is supported by models in the immature rat and baboon. Under these circumstances, the ventricular zone may serve as an area from which tissue regeneration/repair takes place. Further research is necessary to clarify these relationships but is enabled *in-vivo* by diffusion MR imaging in the human preterm infant.

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