Corroboration of disorganized fetal brain lamination on postmortem MR and DTI with autopsy findings

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Background: The normal fetal brain demonstrates laminar organization during development and this has been evaluated using postmortem structural MR and diffusion tensor imaging (DTI) and correlated with histological examination (1,2). Maas et al (3) have found DTI improved the demonstration of laminar organization relative to structural MR in premature neonates. In fetus with brain malformations, it is likely that this laminar organization of the fetal brain will be disrupted. The aim of this study is to evaluate the laminar organization of the fetal brains with suspected malformations, using structural postmortem MR and DTI, and correlate this with autopsy findings.

Methods: 21 fetuses, varying from 16-32 gestational weeks (mean 23 gestational weeks) with suspected brain malformations on antenatal imaging were recruited into the study. Informed consent was obtained for imaging and autopsy. Following dissection, the brain was immersed in 10% buffered formalin for a period of two weeks. The brain was scanned on a 1.5 T MR, immersed in formalin. Structural MR imaging, including T1 and T2 images, and DTI were performed. Presence or absence of normal laminar organization was evaluated on both structural MR and FA maps. Presence of normal laminar organization of the fetal brain was defined as the presence of the germinal matrix, intermediate zone, subplate layer and the cortex. This was compared with histological examination at autopsy.

Results: There was agreement between structural MR assessment of brain lamination and autopsy assessment of brain lamination in 18/21 (86%) cases (χ^2=8.75, p<0.01). The diffusion tensor imaging was not diagnostic in three cases due to artifacts and/or tissue decomposition. In 15/18 (83%) cases, there was agreement between DTI assessment of brain lamination and autopsy findings (χ^2=9.24, p=0.01). Normal laminar organization of the fetal brain on histology was present in six cases. However, structural MR and DTI detected normal laminar organization in three of the six cases. In the three cases where there was disagreement between structural MR & DTI and autopsy findings, one had evidence of ischemia, another had vascular abnormality of the placenta and the third had mild degree of edema.

Conclusions: High resolution structural MR imaging and DTI demonstrated excellent corroboration with autopsy findings of abnormal laminar organization in the fetuses. Currently, T1 weighted imaging and DTI has not been optimized for *in-utero* MR imaging and the resolution of *in-utero* MR is also limited. Knowledge gained on the abnormal laminar organization of the postmortem fetal cerebrum using structural MR and DTI will serve as a template for evaluating abnormal laminar organization in *in-utero* MR in the future.

(a) (b)

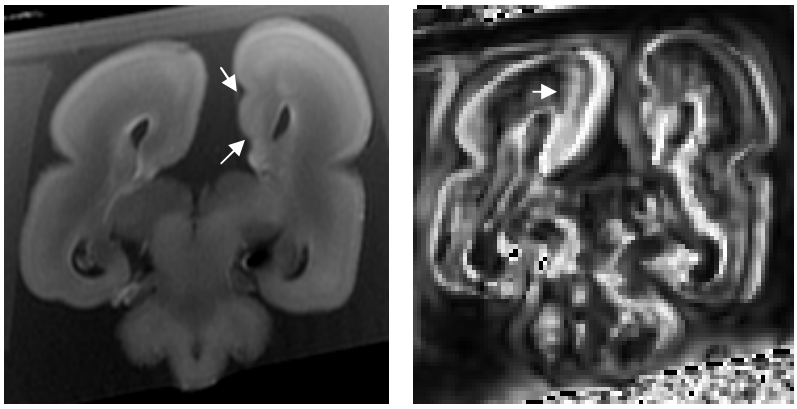

Fig 1. (a) Coronal T1 image demonstrates abnormal laminar organization medially with poor distinction of the intermediate zone, and also abnormal gyration and sulcation pattern medially in the left hemisphere (arrows) and agenesis of the corpus callosum. (b) Coronal FA map acquired from diffusion tensor imaging shows abnormal lamination medially in the left hemisphere.

References:

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