

Fetal MRI beyond Morphology

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While fetal MRI has been used for more than a decade for morphological visualization of normal and compromised maturation of fetal and extrafetal intrauterine structures, functional and metabolic aspects have only recently been considered.

Feasibility of prenatal functional and metabolic MRI studies is widely based on speeding up of the respective sequences. While regular diffusion-weighted sequences can be acquired within about 20 seconds (1), the acquisition of a diffusion-tensor sequence with 32-36 directions in the brain takes more than 60 seconds (2). The same is true for blood-oxygen-labeled (BOLD) sequences and spectroscopy. Consequently, in only 50-75% of unsedated fetuses will information be sufficient (3). Applications that are not compromised by fetal movement are imaging of placental perfusion (that can be done by means of contrast media or by diffusion-weighted imaging)(4), and recording of fetal movement patterns, using dynamic steady state free precession sequences.(1) To date, experience in prenatal functional and metabolic imaging has been gathered with respect to placental perfusion in normal development and pathological states as, for instance, associated with intrauterine growth restriction.(4) In addition, cerebral connectivity has been described with normal(2) and pathological conditions. As well in malformations as in acquired pathology, such as intracerebral hemorrhage, the presence/absence, or displacement of fiber bundles might give clues to prognosis. Functional MRI is feasible using bold imaging. To date, resting-state examinations have resulted in visualization of activity the localization of which differs from that of mature brains. Visual stimulation has been shown to lead to activation in the calcarine cortex from gestational week (GW) 24 onwards. Single voxel spectroscopy can be performed in the brain, where age-related characteristic patterns of metabolites are known.(2) Lactate may be detected in some fetuses, the pathological significance of which has not been clarified completely. Fetal movement patterns have been interpreted to be the output of the maturing fetal nervous system. So-called general movements can readily be recorded using MRI. Pathological patterns can be observed in fetuses with brainstem abnormalities. In addition impairment of movement may be detected in musculoskeletal diseases. Intrinsic movements, such as eye motility, may also be recorded. There maturation of gaze has been studied qualitatively and quantitatively by our group. In conclusion, fetal MR-methods may be used to receive functional and metabolic information of the fetus and placenta respectively. In addition to morphology these methods give further insight into normal and pathological prenatal development.

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4. Javor D Nasel C, Prayer D Diffusion Tensor Imaging (DTI) Based Diffusivity Profile Alterations in the Human Placenta Relate to Intrauterine Growth Restriction (IUGR), ECR 2010, scientific exhibit