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# Diffusion tensor imaging of the fetal spinal cord

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## Objective

Diffusion Tensor Imaging (DTI) of the fetal brain is a relatively new technique to study central nervous system white matter tracts throughout pregnancy and also in certain pathological conditions. The objectives of this study were 1) to evaluate the feasibility of DTI of the spinal cord in utero and 2) to examine age-related changes in the DTI parameters during pregnancy.

## Methods

As part of the Lumiere on the Fetus trial (NCT04142606), we conducted a prospective study, between December 2021 and June 2022 on the Lumiere Platform in Necker Hospital (Paris, France). We included women between 18 and 36 weeks of gestation, without fetal or maternal conditions. Sagittal diffusion-weighted scans of the fetal spine was acquired on a 1.5T MR imaging scanner without sedation. The imaging parameters were as follow: 15 noncolinear direction diffution-weighted magnetic-pulsed gradients with a b-value=700s/mm² and one B0 image without diffusion-weighting, slice thickness=3mm, FOV=36mm, voxel size=4.5x2/8x3mm3, TR=2800ms, TE minimum and acquisition time 2.3 minutes. DTI parameters such as fractional anisotropy (FA) and apparent diffusion coefficient (ADC) were extracted at the cervical, upper thoracic, lower thoracic and lumbar levels of the spinal cord. Cases degraded by motion artifacts or aberrant reconstruction of the spinal cord on tractography were excluded. Pearson's correlations were performed to evaluate age-related changes of the DTI parameters during pregnancy.

## Results

During the study period, 42 women were included in this study at a median gestational age (GA) of 29.3 [18.1-35.7] weeks of gestation. 5/42 (11.9%) of the patients were not included in the analysis because of fetal movement. 2/42 (4.7%) of the patients with aberrant tractography reconstruction were also excluded from analysis. Acquisition of DTI parameters were feasible in the 100% of the remaining cases (35/35). Increasing GA was correlated with increasing FA averaged over the entire fetal spinal cord ($r=0.36$, $p<0.01$) as well as individual regions (cervical level ($r=0.519$, $p<0.01$), upper thoracic level ($r=0.468$, $p<0.01$), lower thoracic level ($r=0,425$, $p=0.02$) and lumbar level ($r=0.427$, $p=0.02$)). There was no correlation between ADC values and GA over the entire spinal cord ($e=0.01$, $p=0.99$) or the individual cervical, upper or lower thoracic, or lumbar segments (respectively $r=-0.109$, $p=0.56$ ; $r=-0.226$, $p=0.22$ ; $r=-0.052$, $p=0.78$ and $r=-0.11$, $p=0.95$).

## Conclusion

This study shows that DTI of the fetal spinal cord is feasible in normal fetuses under typical clinical practice conditions and allows us to extract DTI parameters of the spinal cord. There is a significant GA-related change of the FA in the spinal cord during pregnancy which may result from decreasing water content as observed during myelination of fiber tracts occurring in utero. This study could serve as a basis for further study of this technique in the fetus, including potential for its use in pathological conditions that impact spinal cord development.