

# Magnetic Resonance Imaging to Enhance the Diagnosis of Fetal Brain Abnormalities *in utero*

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## **Abstract**

### *Purpose*

This thesis aims to determine the diagnostic performance of in utero MR (iuMR) imaging to diagnose fetal brain abnormalities and describes the development, application and processing of a 3D volume MR acquisition.

### *Methods*

A systematic review and meta-analysis of existing evidence was conducted. A prospective multicentre study of pregnant women, with a fetal brain abnormality on ultrasound (USS), was undertaken – The MERIDIAN study. In addition, an investigation of fetuses with no brain abnormality on USS was undertaken. Diagnostic accuracy and confidence, as well as positive and negative predictive values, were calculated. A 3D image acquisition technique was introduced, its ability to aid diagnosis measured and computational post-processing applied. Fetal brain volumes were extracted from the 3D data using image segmentation and these were assessed for reproducibility and validity. Resultant data allowed 3D models of fetal brains to be printed. Normally developing fetal brain volumes were plotted graphically thereby allowing comparison with abnormal fetuses.

### *Results*

A total of 570 complete datasets were available from 903 eligible participants. Diagnostic accuracy was 68% for USS and 93% for iuMR. 95% of diagnoses made by iuMR were reported with high confidence compared to 82% on USS. Changes in pregnancy management occurred in 33% of cases. Positive and negative predictive values of iuMR were 93% and 99.5% respectively. 3D image quality was diagnostic in 89.6%, of which 91.4% gave an accurate diagnosis. Intra- and inter-observer agreement of brain volume measurements was high. Agreement between computer based and brain model volume measurements was also high.

### *Conclusions*

iuMR imaging improves diagnostic accuracy and confidence for fetal brain abnormalities, influencing pregnancy management in a high proportion of cases. 3D imaging enables versatile visualisation of fetal brain anatomy and reliable extraction of volumes. This additional quantitative information could improve diagnosis in relevant cases.