3435 - In-vivo 3D Magnetic Resonance Volumetric Analysis of Fetal Cerebellum: From normal to pathology (unilateral cerebellar hypoplasia)

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Context

- MR imaging (MRI) is increasingly being used for the fetal central nervous system studies in vivo. Increasing number of **quantitative studies dedicated to early brain development** in fetuses -> focus to normal development and to some pathologies (eg ventriculomegaly, intra-uterine growth restriction).
- Quantitative **studies of development of the cerebellum based on 3D MRI are rare** [1,2]. Developmental and clastic **cerebellar pathologies include abnormal biometry** and are in daily clinical practice **explored using MR imaging** especially during the second half of the pregnancy [3,4].

Purpose - We present the **quantitative study of cerebellum volume from 3D high resolution reconstructed MRI** in healthy population of fetuses from 26 to 34 weeks of gestational age (GA) and we report **one case study with unilateral cerebellar hypoplasia**.
Our aim is two fold:

1) to study the **validity of having data coming from different MR scanners with slightly different acquisition parameters**
2) to test the **validity of 3D cerebellar volume measurements from MR for diagnosis**.

Materials and Methods

1. Data

Imaging was performed on 2 healthy fetuses (26 and 28 GA) acquired at Lausanne University Hospital (CHUV) using a HASTE sequence (TE/TR = 180/7000ms) on a 1.5T Siemens Aera with resolution 1.125 × 1.125 × 3.6mm^3 and on 8 fetuses (from 29 to 34 GA) from Hôpital Femme Mère Enfant (HFME), using a SSFSE sequence (TE/TR =180/7000ms) on a 1.5T Philips with resolution 1.09 × 1.09 ×5.5mm^3.

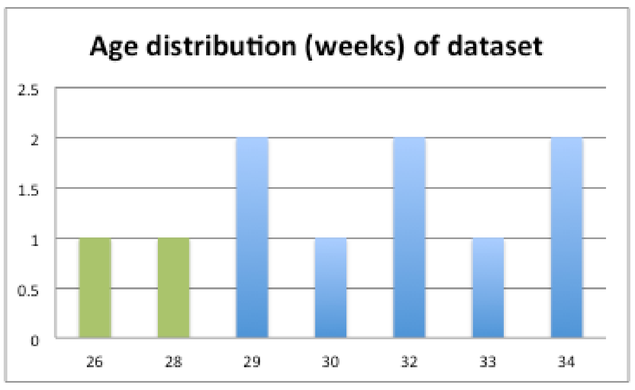


Fig 1. Age distribution of subjects (in weeks of GA): CHUV (green), HFME (blue).

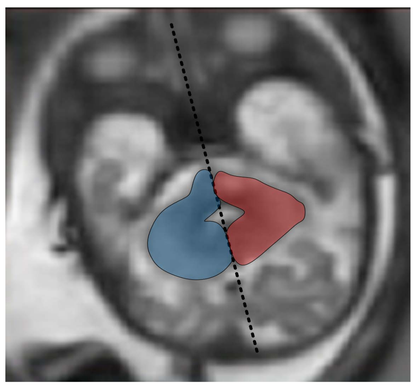


Figure 2. Axial slice of HR MRI image of fetus with cerebellar hypoplasia at 33.5 weeks of GA.

2. Image reconstruction

For each fetus, all available low-resolution stacks (at least three different orthogonal acquisitions) were reconstructed into a high-resolution image using the motion compensation and registration approach in [5].

3. Segmentation

Manual delineation of the cerebellum was done using MITK [6], primarily on the axial plane and with review of the coronal and sagittal planes. Volume computation was done as number of voxels by the voxel resolution and the separation into two hemispheres was done by the supervised extraction of the mid sagittal plane for each fetus.

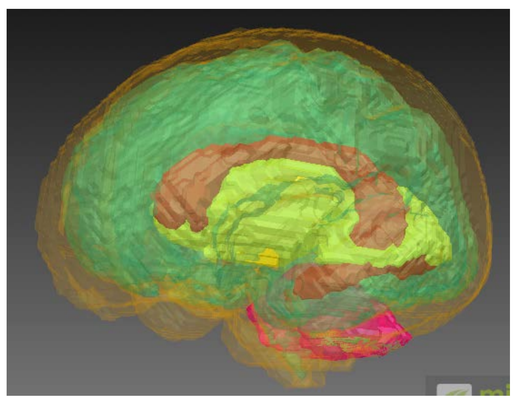


Fig. 3. 3D reconstruction of the cerebrospinal fluid (orange), the parenchyma (green), the ventricles (red), the central grey matter (yellow), the cerebellar region (pink)

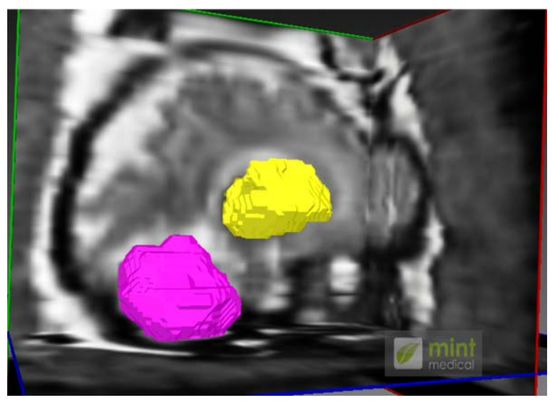
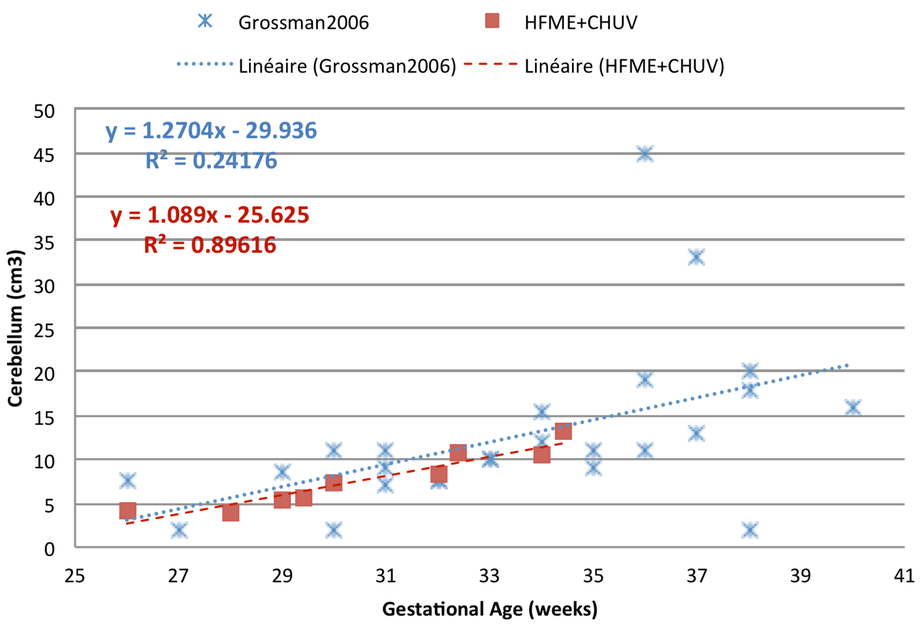


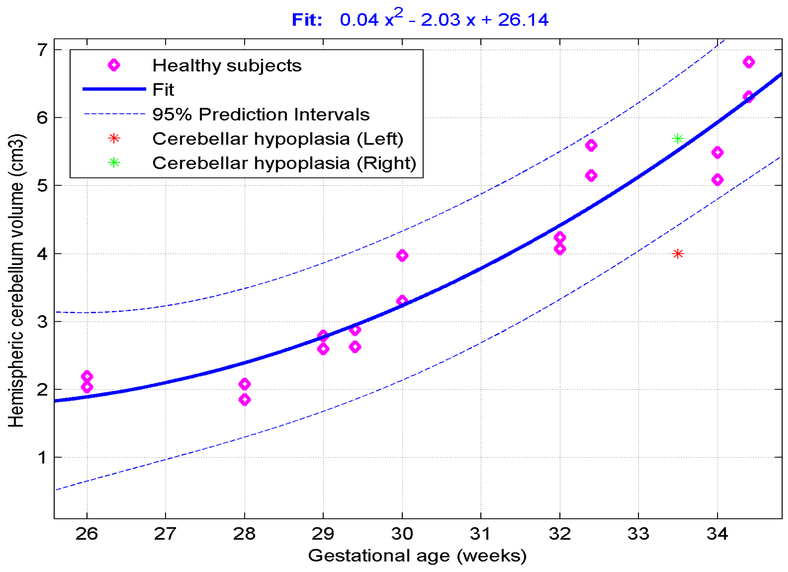
Fig. 4. 3D reconstruction of the central gray matter (yellow) ant the cerebellum region (pink)

Results

- We first report the total **cerebellar volume of our healthy data set as function of the GA** (see here after, in red). We compare our values with those initially published in [1] by Grossman et al (in blue) observing very close behaviour. Our values are also in accordance with most recent studies [2].



- We study the **cerebellar volume per hemisphere**: healthy hemispheric volumes, left and right confounded, are in pink; the patient with cerebellar hypoplasia is depicted in green (healthy right hemisphere) and red (pathological left hemisphere). A polynomial fit on healthy population is estimated (solid blue) with the confidence margins at 0.05 significance level (dashed lines). We can observe that the **hypoplasic hemisphere is not included within the confidence interval**.



Discussion

- Only one recent study attempt **to quantify cerebellar fetal volume from 3D high-resolution reconstruction MRI** data [2]. Our findings confirmed data reported in there [2] and in previous studies [1] in which segmentation was based on low-resolution stacks.
- We concluded, that, **despite the differences in acquisition conditions and image resolution, volumetric results between different datasets can be compared** and used together to increase statistical power when few dataset are available.
- We reported **a case of unilateral hemispheric hypoplasia**, showing a significant decrease of one hemispheric volume using 3D MRI quantitative analysis. This suggests that **quantitative volumes extracted from 3D MRI could be used as complementary tool to diagnose and evaluate pathologies of the cerebellum.**
- Quantitative measures from reconstructed fetal MRI could therefore be used for **other developmental pathologies, like hemorrhagic or ischemic lesions.**

References: *[1] Grossman 2006 [2] Scott 2013 [3] Garel et al J Child Neuro 2011, [4] Massoud et al Ultrasound Obstet Gynecol. 2013, [5] BTK [6] MITK.*
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