

# Calculation of cerebellar volume using an automatic segmentation model and differences between cerebellar volume in IUGR vs normal weight fetuses

Camargo-Marín L, Borboa-Olivares H, Velásquez-Rodríguez G, Arámbula-Cosío F, Medina-Bañuelos V, Prieto- Rodríguez S, Cabrera-López G, Guzmán-Huerta M National Institute of Perinatology in Mexico, Mexico City, Mexico

## Objective

To develop an automatic segmentation model to measure the cerebellum volume using a three-dimensional (3D) ultrasound technique and apply this method to evaluate differences between intrauterine growth-restricted fetuses (IUGR) vs appropriate-for-gestational age (AGA) fetuses.

#### **Methods**

The study was conducted between November 2016 and March 2017 at the National Institute of Perinatology in Mexico. In the first phase, 30 healthy patients were included in the second and third trimesters of pregnancy, a 3D volume was taken of the entire skull starting from the modified axial plane, later in a offline analysis a expert in 3D ultrasound made the annotations of the edges of the cerebellum using 45 axial planes including the whole structure This process was carried out using the software MatLab as a platform, with the purpose of training the automatic model so that later it could perform the recognition of the structure without the need of an operator. With these annotations, the software could calculate the total volume of the cerebellum. Three different models were evaluated and finally the one that was based on the use of the statistical model of spherical harmonics was chosen as it was the most reproducible. To evaluate these three models we used the DICE correlation coefficient. In the second phase, 10 patients with a diagnosis of intrauterine growth restriction (weight less than the 3rd percentile using the Hadlock formula with normal fetal hemodynamic evaluation) and 10 patients whose fetuses had an adequate weight for gestational age (weight between 10th percentile and 90th percentile) were included. For the statistical analysis we used SPSS version 20, with the Mann-Whitney U test tool. Statistically significant differences were considered at a cutoff of p<0.05.

## Results

When the automatic model for segmentation of the cerebellum and calculation of its volume was compared with the manual calculation of the volume with the tool VOCAL of General Electric (4D view), it was shown that the automatic model is a very reproducible tool, with a DICE correlation coefficient of 0. 75, which is considered as a very good match. One of the most important advantages of the automatic model, is the speed of calculation, The automatic model required an average 15 seconds to obtain the total volume of the structure and the manual measurement while VOCAL carried out by an expert takes between 90 -120 seconds on average. Another advantage is that the automatic model does not require the manipulation of an expert to estimate the volume of the structure which reduces operator bias. When differences were calculated between the two groups (fetuses with intrauterine growth restriction "group A" vs fetuses with adequate weight "group B") statistically significant differences were found, the median volume of cerebellum in group A was 2. 67 cm3 vs the median in group B of 4. 87 cm3, p = 0. 02.

## Conclusion

The automatic segmentation method performed well for the automatic measurement of the 3D volume of the fetal cerebellum and allowed us to find statistically significant differences between the cerebellar volume of IUGR fetuses compared to AGA fetuses. This automatic model is not exclusive to cerebellum segmentation and can be used in other fetal structures, as long as a 3D volume of the structure can be taken. It only requires a short period of training, in which an expert performs the feeding of data to the model after which it then works automatically. Currently as part of this research area the model is being used for the measurement of the volume of kidneys, lungs, liver, suprarenal glands and other structures of the central nervous system in the fetus, so it could become a very useful tool for the evaluation of

fetuses with different pathologies.