Supplementary Material

APPLICATION OF AUTOMATIC SEGMENTATION ON SUPER-RESOLUTION RECONSTRUCTION MR IMAGES OF THE ABNORMAL FETAL BRAIN

Table 1: Underlying conditions of the fetal MRI cases that were used in our study (testing dataset).

Pathology	Amount of cases
Tuberous sclerosis	1
Spinal dysraphism (Chiari II malformation)	2
Corpus callosum abnormality (complete or partial agenesis)	3
Intracranial hemorrhage	1
Aqueductal stenosis	1
Dandy Walker continuum	2
Idiopathic dilatation of the lateral ventricles	1
Cytomegalovirus encephalitis	2
Idiopathic cerebral parenchyma loss*	1

**Presumably due to a germinative matrix bleeding with associated venous infarct, resulting in atrophy.*

Table 2: Scanning metrics of T2 weighted single-shot turbo spin echo sequences of the fetal brain from our clinical routine protocol for in utero fetal MRI.

MRI Metrics	
Repetition Time	1000ms
Echo Time	133ms
Field of View	300 x 243mm, adjusted up to 380 x 308mm, depending on patient size
Acquired voxel size	1.36 x 1.17 x 3.00mm, adjusted up to 1.72 x 1.48 x 3.00mm, depending on patient size
Reconstructed voxel size	0.59 x 0.59 x 3.00mm, adjusted up to 0.74 x 0.74 x 3.00mm, depending on patient size
Spacing between slices	0mm

Table 3: Underlying conditions of the fetal MRI cases with CNS abnormalities other than spinal dysraphism, that were used in the training dataset of the algorithm.

Pathology	Amount of cases
Tuberous sclerosis	1
Dandy Walker continuum	1
Corpus callosum abnormality (complete or partial agenesis)	3
Intracranial hemorrhage	2
High flow dural sinus malformation	1
Partial rhombencephalosynapsis	1
Enlarged subarachnoid space	1

Table 4: Baseline scanning parameters of post-mortem MR protocol of the brain and body. Adaptions were performed based on fetal size to optimize field of view and resolution.

	TE (ms)	TR (ms)	FOV APxRLxFH (mm)	Voxel APxRLxFH (mm)	MATRIX APxRLxFH	NSA	Acquisition time
3D T1w GE Brain	4.1	9.4	180x140x72	0.5x0.5x0.5	360x144x120	2	02m14s
3D T1w GE Body	4.0	9.2	180x120x88	0.5x0.5x1.6	360x216x252	2	02m23s
3D T2w FSE Brain	622	2800	140x140x70	0.5x0.5x0.5	280x225x280	2	13m07s
3D T2w FSE Body	622	2800	180x180x70	0.5x0.5x0.5	360x225x280	2	13m07s
DTI Brain	91	7600	180x180x100	2.5x2.5x2.5	72x72x40	1	10m32s
GE Brain	16	1863	96x96x176	0.8x0.8x2	120x120x80	1	01m54s

GE = gradient echo sequence, T1w = T1-weighted, T2w = T2-weighted, FSE = fast spin echo, DTI = diffusion tensor imaging, TE = echo time, TR = repitition time, FOV = field of view, AP = anteroposterior, RL = right-left, FH = foot-head, NSA = number of signal averages.

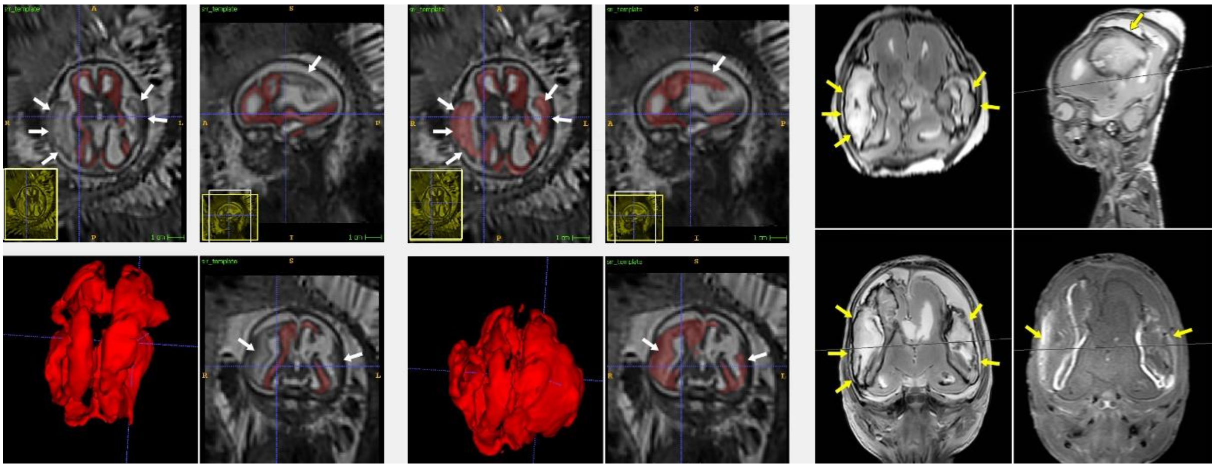

Figure 1a: Case of intracranial hemorrhage sequelae (gestational age: 25 weeks). White matter manual segmentation on the left, automatic in the middle, post-mortem on the right. All images are T2 weighted, except for the bottom right one of the post-mortem study, which is T1 weighted.
There are bilateral hemorrhages, the components with low signal intensity are included by the algorithm (arrows).

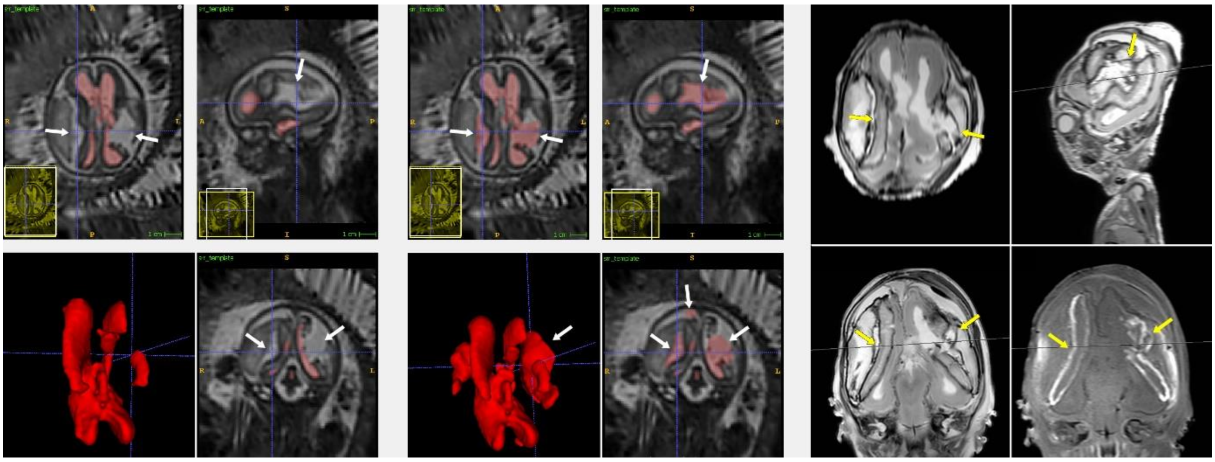

Figure 1b: Case of intracranial hemorrhage sequelae (same case as 1a). Ventricular system manual segmentation on the left, automatic in the middle, post-mortem on the right. All images are T2 weighted, except for the bottom right one of the post-mortem study, which is T1 weighted.
There are bilateral hemorrhages, the components with high signal intensity, as well as extra-axial fluid parts and porencephalic cysts are included by the algorithm (arrows).

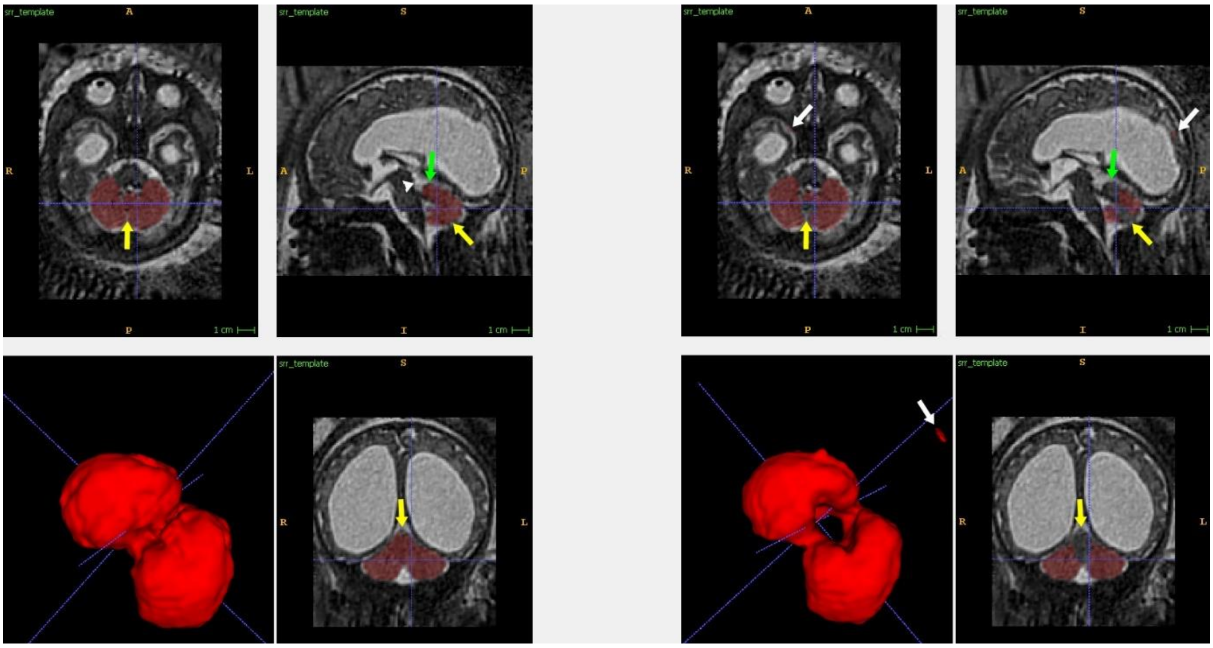

Figure 2a: Case of aqueductal stenosis (gestational age: 39,7 weeks). Cerebellum manual segmentation on the left, automatic on the right.
The cerebellar folia in the vermian region have a higher signal intensity than the other parts of the cerbellum, due to partial volume effect. This area is less included by the automatic algorithm, as well as the anterior lobe (yellow and green arrows respectively). Additionally there are a few outlier voxels which are included by the algorithm (white arrows), note that these are in the excluded 5% of Hausdorff distance at percentile 95. The stenotic aqueduct is indicated on the left (white arrowhead).

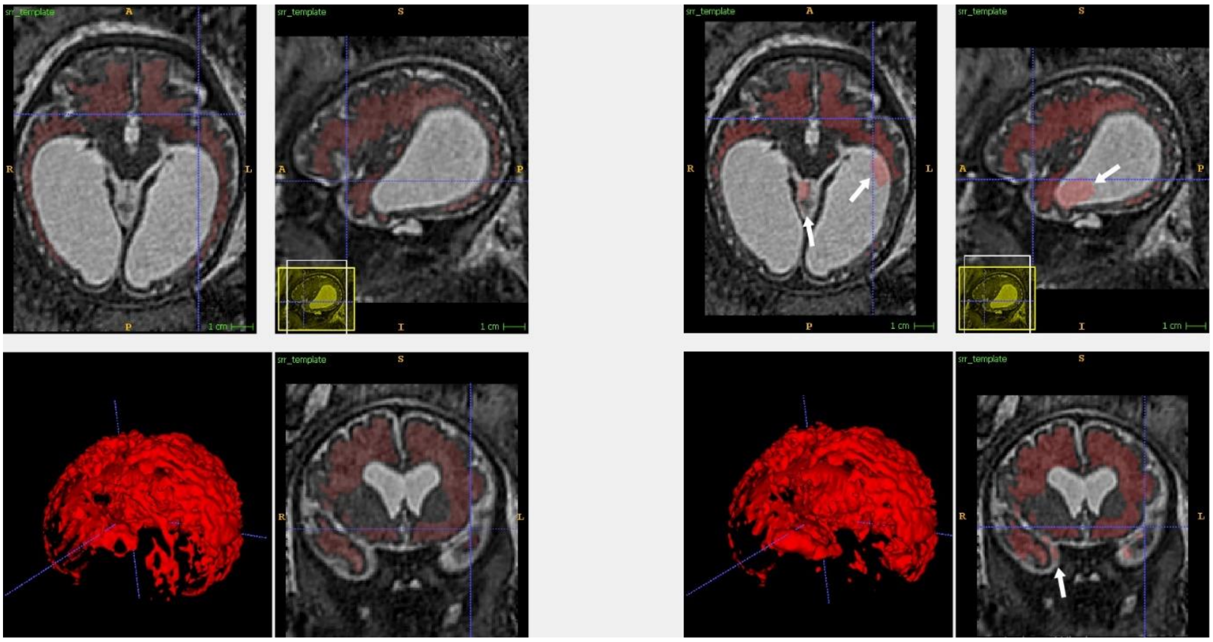

Figure 2b: Case of aqueductal stenosis (same case as 2a). White matter manual segmentation on the left, automatic on the right.
The aqueductal stenosis causes dilatation of the supratentorial ventricle system, which in turn causes overlaying white matter atrophy. This results in a thin and irregular segmentation, both manually and automatically. Additionaly the algorithm includes adjacent parts of the lateral ventricles, extra-axial cerebrospinal fluid and vermis (white arrows).

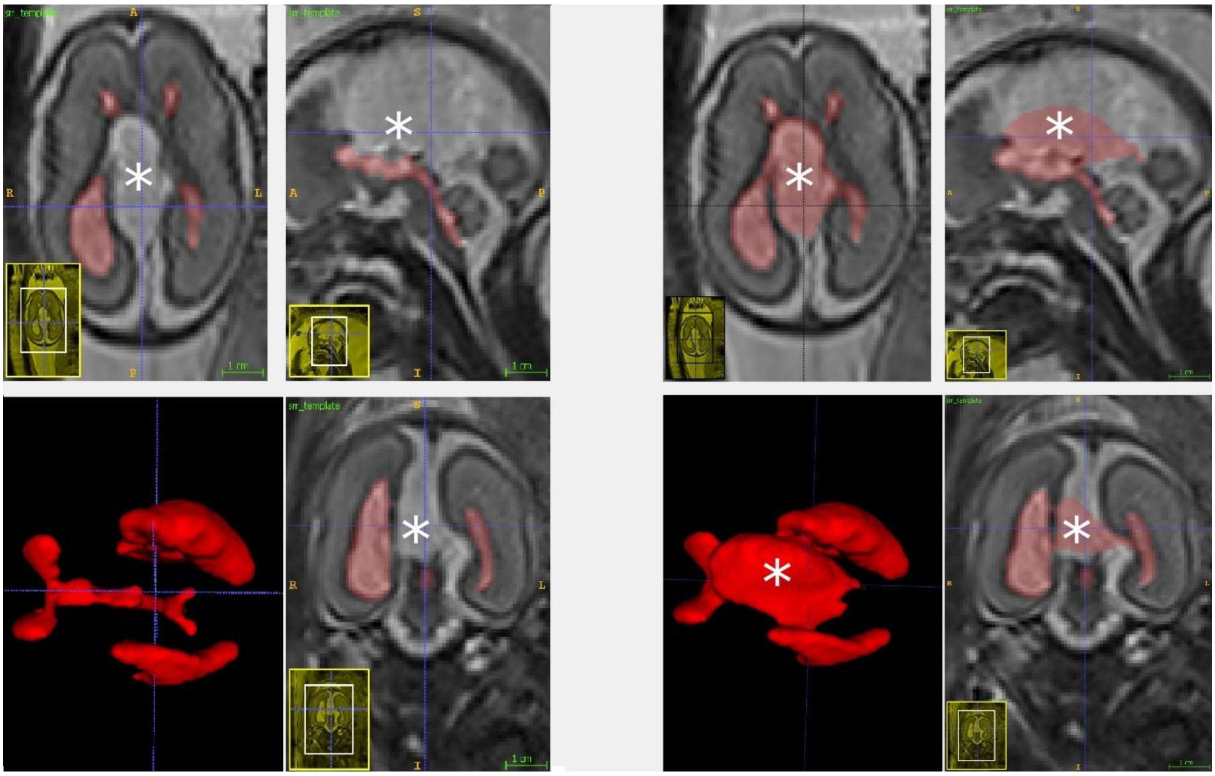

Figure 3a: Case of partial corpus callosum agenesis (gestational age: 23,6 weeks). Ventricular system manual segmentation on the left, automatic on the right.
There is an associated interhemispheric cyst (asterisk), which the algorithm includes in the segmentation of the ventricle system.

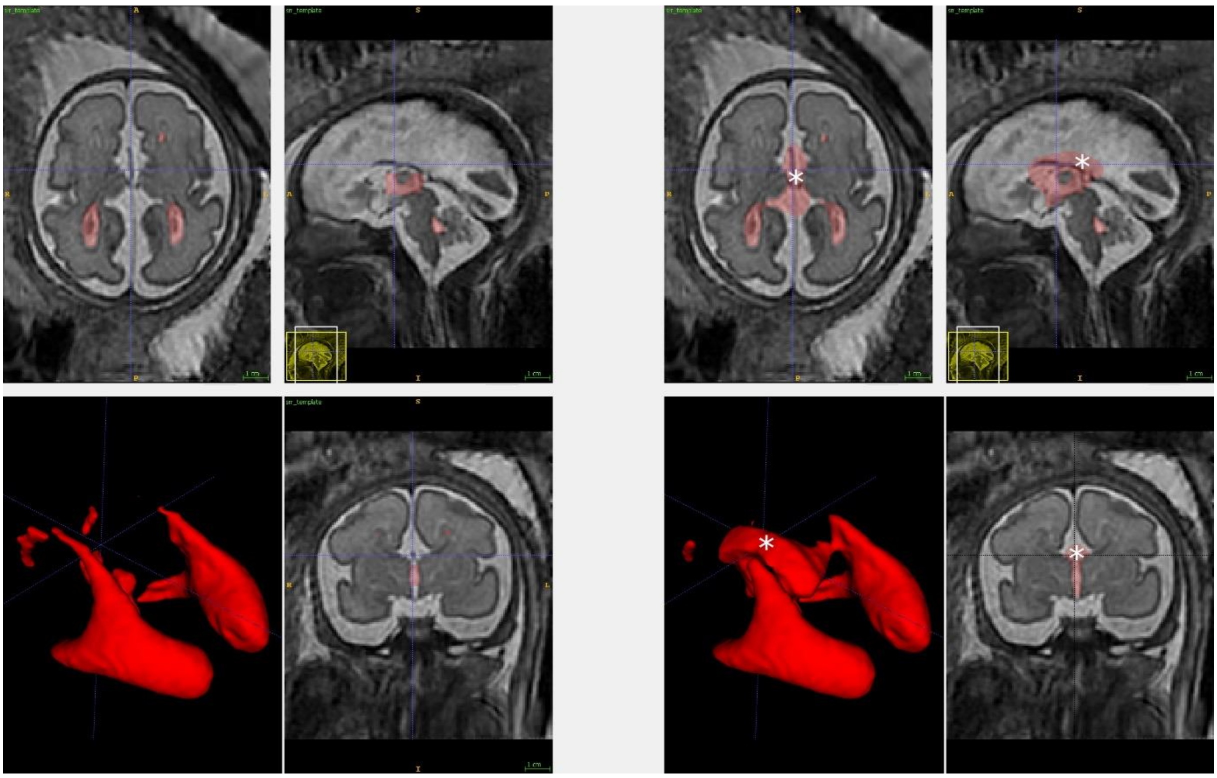

Figure 3b: Case of corpus callosum agenesis (gestational age: 29,7 weeks). Ventricular system manual segmentation on the left, automatic on the right.
Absence of a cavum septum pellucidum, instead the algorithm includes parts of the interhemispheric cistern (asterisk).

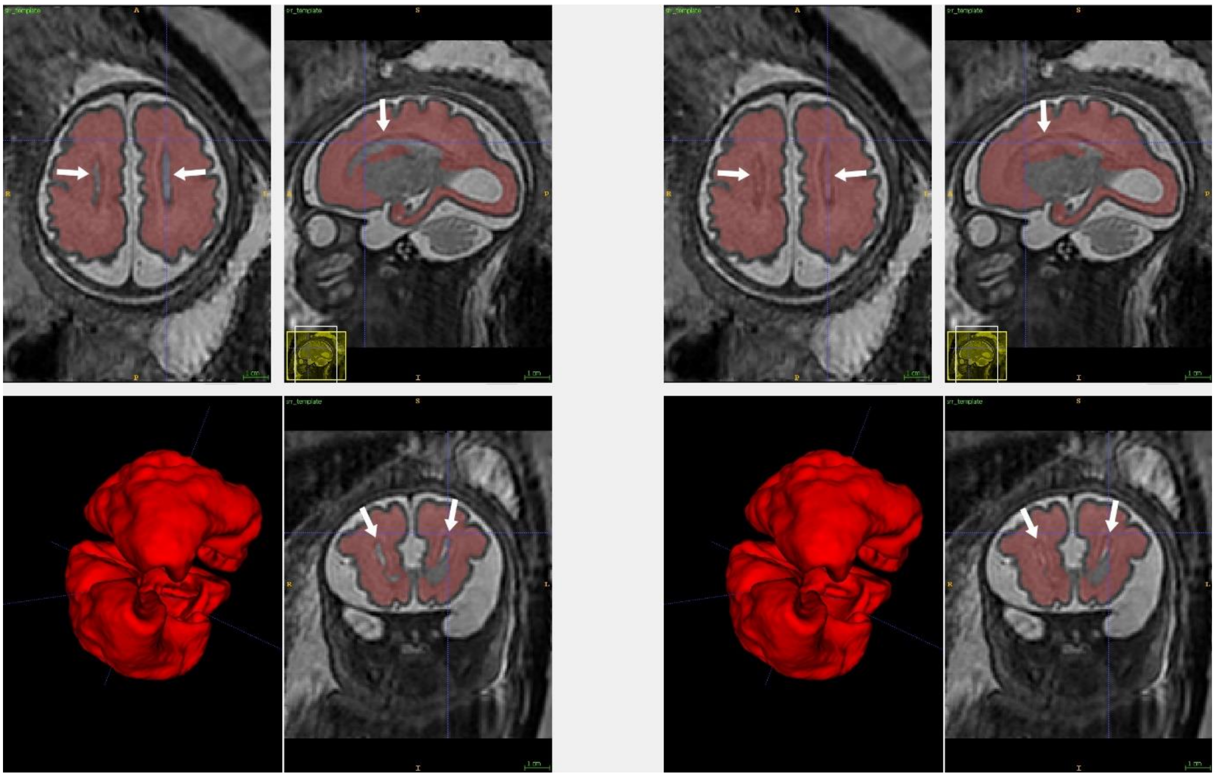

Figure 4: Case of corpus callosum agenesis (same case as 3b). White matter manual segmentation on the left, automatic on the right.
There is a lower signal intensity of the voxels in the sides of the lateral ventricles (arrows), due to partial volume effect. These are included by the algorithm.

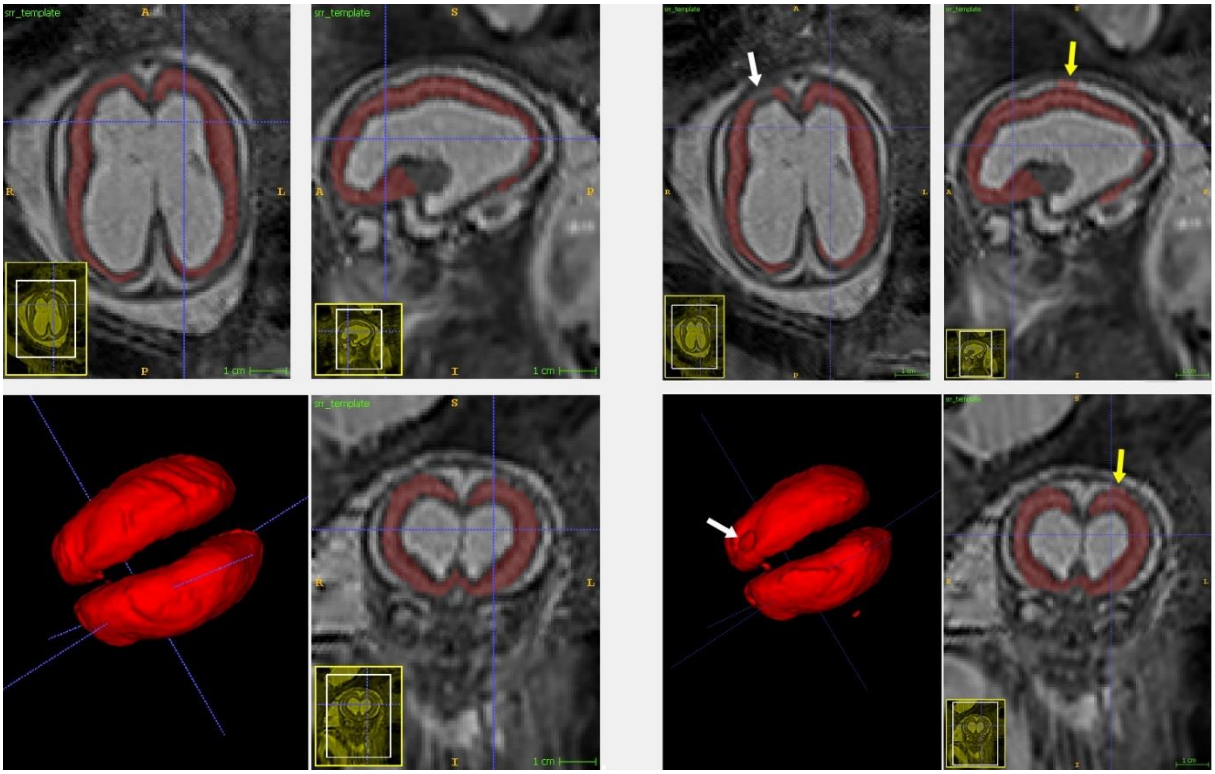

Figure 5: Case of idiopathic dilatation of the lateral ventricles (gestational age: 21,6 weeks). White matter manual segmentation on the left, automatic on the right.There is a thinned and more irregular appearance of the white matter due to ventriculomegaly. Note both under- and oversegmentation near the skull by the algorithm (white and yellow arrows respectively).

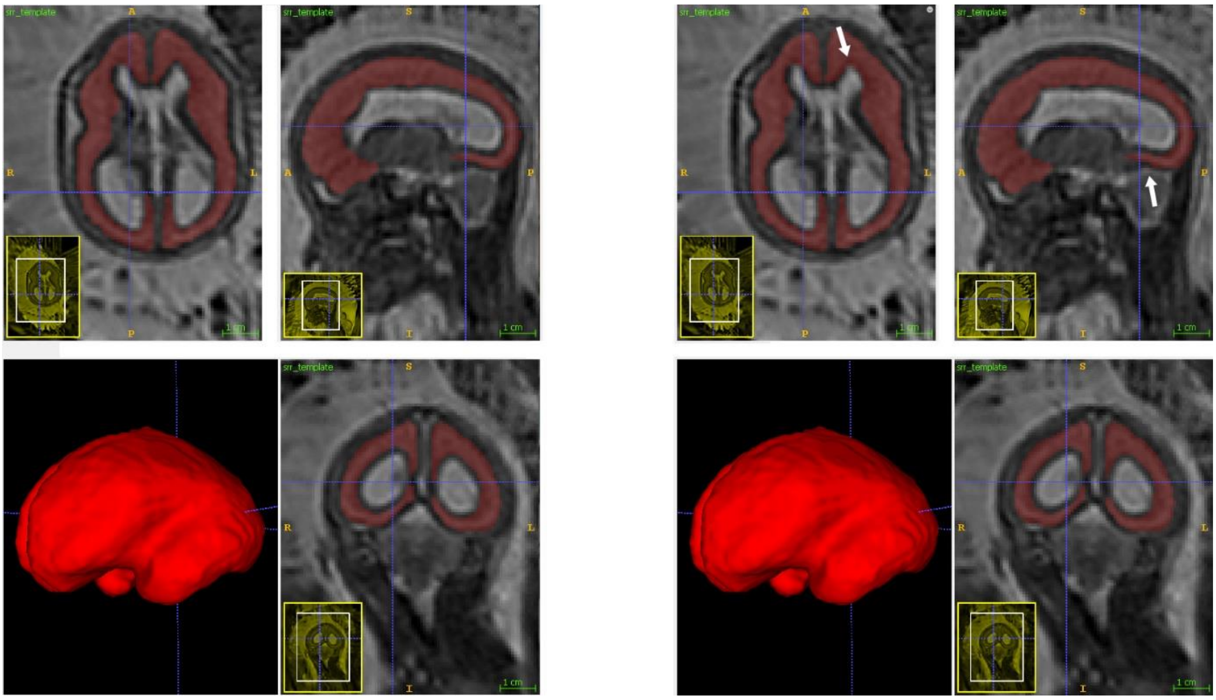

Figure 6: Case of Chiari II malformation (gestational age: 23,3 weeks). White matter manual segmentation on the left, automatic on the right.
There are only minimal oversegmentation errors by the algorithm (white arrows).