A Neonatal Piglet Brain Database with High Resolution MRI

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Purpose:

The neonatal piglet is well accepted preclinical model for translational studies on effects of early-life experiential factors on brain and cognitive development. MRI for in vivo assessment of brain development in young piglets was investigated [Conrad, *et al*. 2012; Radlowski, *et al*. 2014]. However, MRI features of brain growth and development have not been well established at this stage. In order to develop MRI methods for estimating brain tissue characters in neonatal piglets, here we aim to obtain high resolution images of piglet brain with ultrahigh field MRI to generate a piglet brain database at ages of less than 12 days old.

Methods:

Fifteen piglet brains were harvested with skull at the age of 12 days. These brains were scanned by a 9.4 T MRI and a 72 mm ID birdcage RF coil. A 3D fast spin echo with T_2 weighted sequence was applied with the following parameters: TR/TE =1500/46 ms, ETL= 16, image resolution = $250 \times 250 \times 250$ um^3, Total scanning time was 1 hour 42 minutes. Fifteen major structures in each brain were segmented with the ITK-SNAP software. The volume of each structure and the whole brain volume were obtained.

Results:

The coronal view of a representative brain image (Fig. 1) showed typical brain structures segmented. A 3D segmented brain were shown in Fig. 2. The volumes of the fifteen segmented structures are listed in Table 1. Noticeably, the volume of the left and right hippocampal formation was similar within each animal with a mean volume of about 880 mm^3 contributing to approximately 2% of piglet brain.

Conclusion:

The brain structures segmented in this study could provide references for *in vivo* assessment of brain growth and development in metabolic and pediatric nutrition research. Ongoing studies will characterize reliable estimates of changes in the brain volume at early neonatal period.

Clinical Relevance

Pigs and humans share similar patterns in brain growth and development. This study develops methods for *in vivo* assessment of brain growth and development in metabolic and pediatric nutrition research.

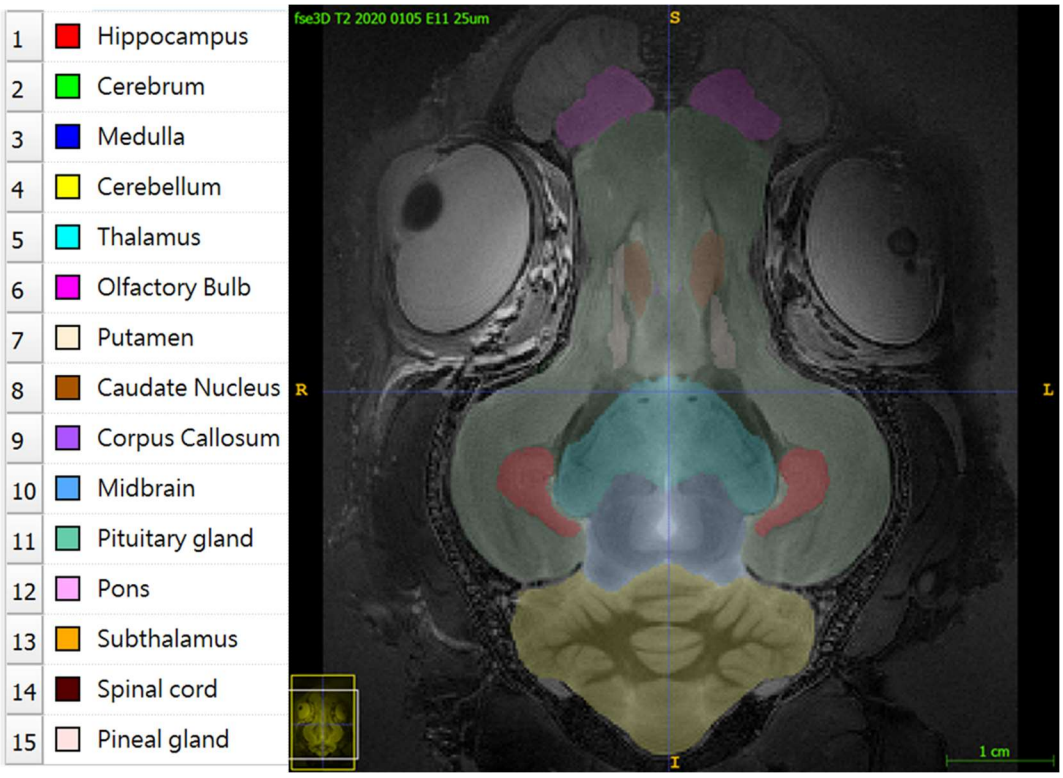

Figure 1. The coronal view of the piglet brain: There are eight structures segmented in this coronal view image, including cerebrum (green), cerebellum (yellow), midbrain (sky blue), thalamus (light blue), olfactory bulb (pink), hippocampus (red), putamen (beige), and caudate nucleus(brown).

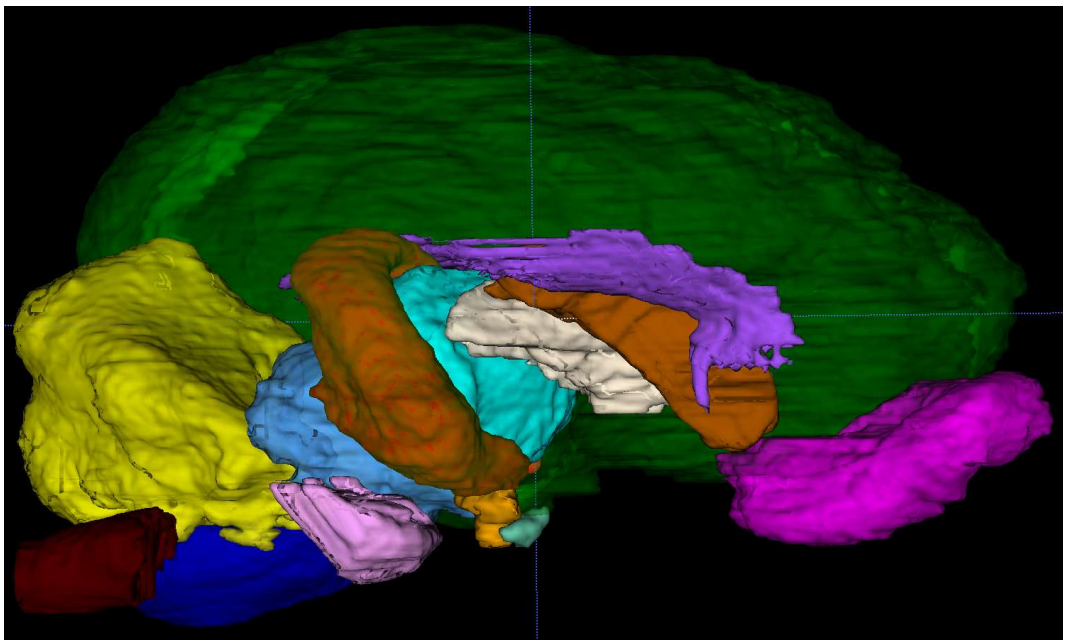

Figure 2. The 3D model of the piglet brain: The model consisted of fifteen structures of the piglet brain, which was made by segmenting each structure slice by slice manually.

Table 1. The volume statistic of each structure.

Structure	Mean volume (mm^3)	Standard deviation (mm^3)	Coefficient of variation (%)
Cerebral Cortex	27944.3596	1832.717538	6.558452452
Cerebellum	4239.066	411.154315	9.699172295
Midbrain	1536.784	109.5914394	7.13121944
Medulla	1310.342	142.5106939	10.87583958
Pons	341.665	32.24376115	9.437244421
Thalamus	1522.693	137.394549	9.023128693
Subthalamus	43.59377	6.017129887	13.80285554
Olfactory bulb	1288.394	120.97495	9.389592776
Hippocampus	822.7432	79.82718265	9.043081006
Putamen	723.2027	62.52665789	8.645799842
Caudate nucleus	457.1378	53.04062186	11.60276439
Corpus callosum	152.7972	28.6580644	18.75562144
Pituitary gland	19.38058	4.359981009	22.49664876
Pineal gland	3.934489	0.923919116	23.48256956
Spinal cord	324.8607	112.4981756	34.62966606
Whole brain volume (exclude spinal cord)	40463.02612	2146.134181	5.302266355