

T2 layering pattern changes in primary motor cortex in the first two years of life: a study on normal children.

A. Righini¹, A. Ardemagni¹, T. J. Re¹, C. Parazzini¹, C. Doneda¹, F. Arrigoni¹, and F. Triulzi¹

¹Radiology, Children's Hospital V. Buzzi, Milan, Italy

Introduction

Very scarce imaging data are available on the features of cortical rim layering pattern over the first two years of life. Even histological analysis of cortical rim changes in normal toddlers are limited. In this retrospective study we took advantage of the high in plane spatial resolution of T2-weighted fast spin-echo (FSE) images to collect normative data on cortical ribbon appearance of maturing primary motor cortex. The knowledge of normal T2-weighted cortical patterns changes overtime might help in better understanding conditions with abnormal cortical development.

Methods

From 2006-2010 data base of our Pediatric Neuroradiology Department, the MR studies of 84 children (44 males and 40 females) from 0 to 24 months of age at scanning, with the following characteristics, were selected: a) normal neuroradiological report; b) studies performed for head and neck diseases, congenital malformations in relatives, peripheral facial nerve palsy; c) normal clinical neurological assessment at minimum five months follow-up as stated by family pediatrician. Children born premature were excluded. MR imaging scans were all performed by the same scanner on 1.5 Tesla Philips-Achieva system, with neonatal dedicated 4 channels head coil or adult 8 channels head coil for children older than 6 months. In subjects below 6 months of age axial FSE T2-weighted sections have been acquired with the following parameters: TR/TE: 6000/200 ms, slice thickness 3.0 mm, nex = 2; in subjects above 6 months of age the axial FSE T2-weighted sections had the following parameters: TR/TE: 5500/120 ms, slice thickness 4.0 mm, nex = 2. In plane resolution was 0.4 mm² for all studies. Axial FSE T2-weighted images were taken into account for the analysis. Image evaluation was performed by using NIH software ImageJ. A senior pediatric neuroradiologist selected the section where the inverse "omega" sign for primary motor cortex of the hand region was visible (figure 1). A line calliper was traced starting from the cortex-CSF interface across cortical rim to a depth of 4 mm. The length of 4 mm was chosen because it could reasonably encompass the area where the myelinated subcortical white matter is expected to appear within the first two years of life. The value of the pixel profile obtained were normalized by CSF signal intensity. Three line callipers have been traced at the level of "omega" for each hemisphere and results have been averaged.

Results

We identified four patterns of cortical T2 signal profile by visual evaluation, which were confirmed by signal intensity plots (figure 1): I) from newborn to 3 months of age a two layers pattern: a single markedly hypointense cortical layer and a deeper markedly hyperintense layer, the latter very probably including the late sub-plate and unmyelinated subcortical white matter; II) from 3 to 10 months of age a "train track like" pattern with hypointense superficial layer, an intermediate relatively hyperintense layer, and a deeper hypointense layer, all included within the cortical rim; in addition a subcortical layer with signal intensity still high and compatible with subcortical unmyelinated white matter; III) from 10 up to 16 months of age progressive attenuation of the intracortical "train track like" pattern and moderate decrease of high signal of subcortical white matter due to myelination; IV) from 16 up to 24 months of age cortical rim appearing as a moderately hypointense single layer in most subjects, with hypointense myelinated subcortical white matter.

Conclusions

Although the intracortical changes reported on MR imaging need to be elucidated by histological correlation, we established how a trend of progression through four patterns of cortical layering can be observed in the normal developing brain.

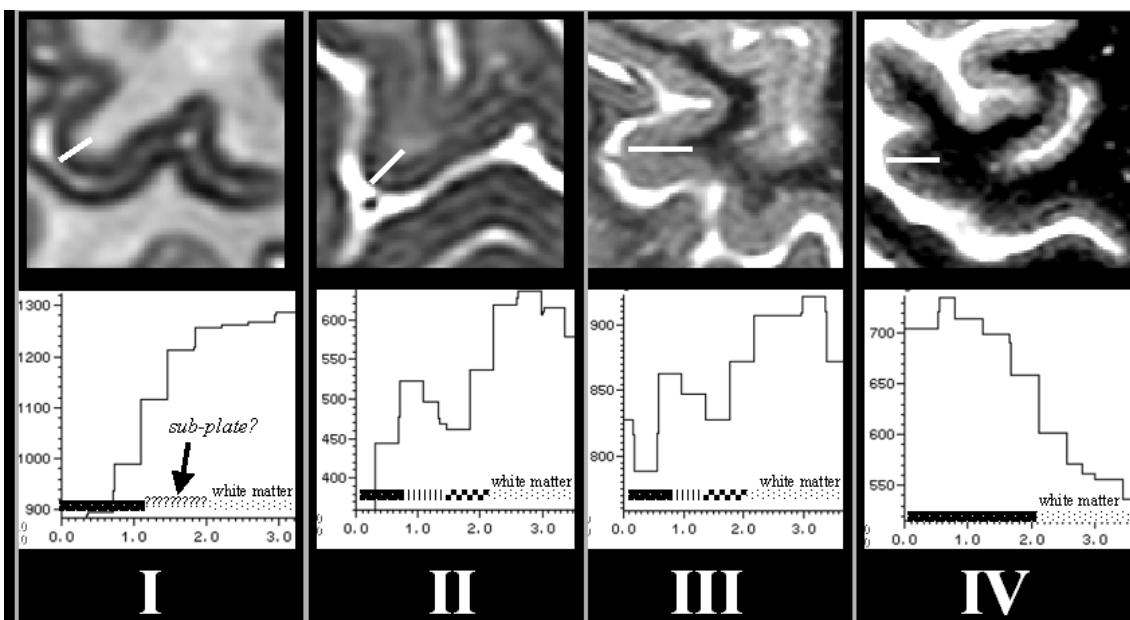


Figure 1: the four patterns of cortical layering changes over time reported in this work: calliper drawings at the level of the primary motor cortex "omega" structure are shown, with relative signal plots (native, non CSF normalized values, and corresponding to a single calliper are shown as example).