Half-quantitative assessment of myelination progression in normal infants and children during 6-48 months with conventional T2-weighted images

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Target audience:

Pediatric radiologist and pediatrician

Purpose:

White matter (WM) myelination is an essential process to postnatal neurologic maturation and can be evaluated by magnetic resonance imaging (MRI). A reasonable and feasible assessment of the myelination in the developing brain is important to evaluate WM development and to diagnose WM disorders in infants and children. During the ages of 6 and 18 months, the changes in WM maturation are showed better in the T2-weighted images (T2WIs) than in T1-weighted images (T1WIs) [1]. So far, there are no normative grading scheme appropriating for infants and children to assess the maturation of myelination. The purpose of the present study was to half-quantitatively assess myelination progression mainly in the subcortical WM during postnatal 6–48 months by conventional T2WIs..

Methods: We retrospectively evaluated 54 infants and children with age of MR scanning during 6–48 months and without diseases potentially affecting WM. The MR studies were performed by a 3.0T MR scanner with 8-channel head coil. The spin-echo T_2WIs were performed by technical parameters as follows: TR/TE=4680/105ms, thickness=5mm without gap, field of view =180×180mm^2, matrix = 256×256 . In this study, two pediatric neuroradiologists assessed the white matter myelination in T2WIs according to Cecilia Parazzini's study [2]. The subcortical WM in bilateral cerebral hemispheres was divided the into five regions as follows: the frontal, temporal, parietal, occipital lobes and peritrigonal region（see Table 1）. Assessment of myelination according to regions with thread-like hypointensity in T2WIs was graded as scores: 0 for the absence of myelin, 1 for the complete myelination. Then, the total scores representing the maturity of cerebral myelination were acquired by summing the grade of above mentioned WM regions. The correlation and regression analysis between the total scores of myelination and ages were statistically analysed by GraphPad Prism5. The agreement of inter-observer and intra-observer was evaluated using Bland-Altman analysis.

Results: The positive correlation between age and the total scores of myelination with nolinear correlation coefficient of 0.843 ($p<0.001$) was found in this study. The nolinear correlation curve had two turning points in age of 10 and 16 months respectively. During the above mentioned time, the total scores of myelination varied very apparently with ages (see Fig. 1). Moreover, the excellent inter-observer and intra-observer agreement were proved by Bland-Altman statistical analysis (see Fig .2).

Table 1 Subdivision of marker sites and summary of grading system

scores	Frontal lobe			Temporal lobe		Parietal lobe		Occipital lobe		Peritrigonal region.	
	Pre-R	Polar	I-II	Lateral	Polar	Post-R	Gyri	Polar	Inner	Posterior	Superior
0	-	-	-	-	-	-	-	-	-	-	-
1	+	-	-	+	-	+	-	+	-	+	-
2	+	+	-	+	+	+	+	+	+	+	+
3	+	+	+	+	+	+	+	+	+	+	+

Note.—R indicates rolandic; I–II, first and second convolutions; +, presence of myelination (absence of T2 hyperintensity); -, absence of myelination (presence of T2 hyperintensity)

Discussion:

The low signal intensity in T2WI corresponding to the age-related myelination progression has been proved in the previous histopathological study[3]. This half-quantitative points-scoring system used in this study referenced to Cecilia Parazzini's study[2] and was proved with good repeatability and reliability for clinical use. In this study, the nolinear correlation between age and the total scores of myelination was found, and indicated the rapid growth of myelination scores during age of 10 to 16 months, which demonstrated the rapid maturation in subcortical WM in this period and is consistent with the previous study[4]

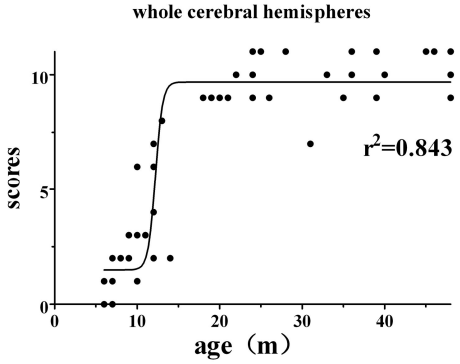

Fig.1 correlation and regression analysis between the scores of whole cerebral hemispheres and ages

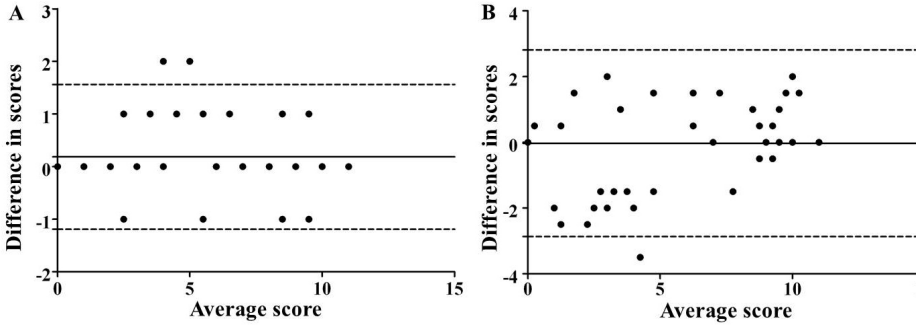

Fig.2 Bland-Altman plot for evaluating the agreement of inter-observer (**A**) and intra-observer (**B**) with average score for each subject plotted against the difference in scores. The solid line represented the mean difference in score, and dotted lines represented 2 SD from the mean.

Conclusion: The half-quantitative points-scoring system used in this study may be useful to assess the stages of a delay or deficit of myelination and helpful to the quantitative descriptions of white matter disorders.

Acknowledgements

This study was supported by a grant from National Natural Science Foundation of China (No. 30970797 to JY)

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