Magnetic resonance imaging of normal and pathological white matter maturation

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Abstract. Fifty children between 3 months postnatal and 16 years of age were examined by means of a 1.5 T superconductive magnet, run at 0.35 and 1.0 T. The myelination was studied qualitatively and quantitatively (relaxation times, proton densities, image contrast). With increasing age, a decrease of T1 and proton density of white matter was found, which was complete at one year of age. In regions with a slow progression of myelination, gray/white matter contrast showed an increase up to the end of the first decade. Pathological white matter maturation was diagnosed either as an abnormal transformation of myelin (characterized by abnormal relaxation values), or as a deficient or delayed myelin formation (in comparison with age-matched controls).

Until recently, human brain maturation could only be characterized on the basis of post-mortem brain slice studies [1] (Fig. 1). The unique gray-white matter contrast found in Magnetic Resonance Imaging (MRI) of the brain provides the opportunity to trace the stages of brain maturation in children in vivo [2, 3]. The purpose of this study was to find a method for the qualitative and quantitative assessment of white matter myelination based on MR data.

Materials and methods

Fifty children (24 male, 26 female) aged from 3 months postnatal to 16 years were examined. MR images were obtained by a 1.5 T superconductive magnet (Magnetom, Siemens) operating at 0.35 T (35 patients) and 1.0 T (15 patients). A 30-cm head coil was used in all cases. T1- and T2-weighted spin echo (SE) sequences were applied to all children. In half of the cases additional inversion recovery (IR) sequences and/or proton density weighted SE sequences (TR=4 s, TE=30 ms) were employed. Only transverse slices with a thickness of 10 mm were used for the evaluation. Under the age of 5 years the children usually required sedation with rectal chloral hydrate (75-100 mg/kg) or chlorprothixene (1 mg/kg) i.v.

Quantitative data were gained from four regions of gray matter (frontal, occipital, caudate nucleus, lentiform nucleus) and
Results

Relaxation times

In Figs. 2 and 3 the T1- and T2-relaxation times at 0.35 T are shown as a function of age. Each dot in