Longitudinal assessment of a myelination pathology in a mouse model by texture analysis of brain images.

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Introduction

The basic hypothesis was that the multilamellar spiral structure of the myelin sheets and their abundance in the white matter must be traduced in the MR T_2-weighted images by a particular pattern of the pixels defined by a high order texture parameter, rather than by the usually used mean intensity which is only a first order texture parameter. The aim was to obtain a longitudinal assessment of brain myelin in the cuprizon mouse model involving a neurotoxic process over two months, in which a transitory remyelination process has already been observed in a histological (destructive) study of myelin ultrastructure.

Materials and Methods

Eight mice C57BL/6J of either gender were used, six were continuously fed with 2% added cuprizon for 8 weeks, and two controls fed without added cuprizon. Four myelin-rich regions, olfactory bulbs, cerebellum, putamen and brain stem, were studied in sagittal contiguous slices over the whole brain, in T_2-weighted images at days 0, 13, 29, 32, 41 and 56. The brain images were obtained on the anaesthetised mice (ip injection of 37mg/kg ketamin + 5,5 mg/kg xylazin) in a 4,7 T scanner (SMIS, UK), spin echo (T_R = 300ms, T_E = 40ms), 256*256 matrix, 0.5 mm thickness slices.

Mazda program [1] was used for a statistical texture analysis of images, which refers to a set of processes applied to characterise spatial variations of pixel's grey levels in apparently homogeneous limited areas devoid of contours. According to the expected organization complexity of the pixels, a statistical method of order higher than two was required. Providing a runlength matrix based on the probability to obtain a number of runs of grey level and length in one of the four orientations, 0°, 45°, 90° and 135°, the most pertinent parameter, horizontal Grey Level Non Uniformity (GLNU) has been screened by a Fisher test.

Results

According to the cuprizon mouse model, the mice underwent an early hydroencephalus visible in the brain slices as ventricles enlargements. Consequently, CSF was taken as the internal reference of each image. Fig.1 shows that the average intensity of the overall four selected regions did not change significantly until day 29, started to increase at day 32 and was then amplified at days 41 and 56. According to the results of immunochemical methods of myelin characterization, this evolution was attributable to the disappearance of myelin. Conversely the higher order texture parameter called GLNU displayed a different evolution, with a continuous and significant decrease, except at day 41 as displayed in Fig 2. At this day 41 this parameter was significantly increased in the cerebellum and olfactory bulbs.

Discussion and conclusion

The evolution of this high order texture parameter 'GLNU' was similar to that described by Matsushima and Morell [2] who performed in the same cuprizon mouse model, the ultrastructural assessment of myelin in corpus callosum, in which demyelination started at 3 weeks, reaching 90% by 4-5 weeks, but temporarily reversed by 6 weeks with about 50 % of the axons again myelinated. By a reference to histological ultrastructure, our high order texture parameter involving a rapid process of MR images, allowed a non invasive longitudinal study of brain myelination with a better sensitivity than immunochemical methods to which the average intensity of T_2-weighted images was referred.

References

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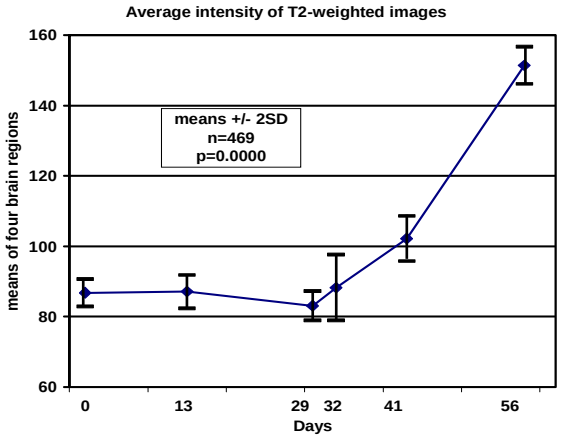

Fig. 1

Fig. 2