On the effect of oral corticosteroids on magnetization transfer imaging (MTI) measurements

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Introduction

Magnetization transfer imaging (MTI) has proven a valuable tool to detect and quantify lesion load in diffuse white matter diseases[1]. However, in some cerebral diseases, such as neuropsychiatric systemic lupus erythematosus (NPSLE), patients are frequently on oral corticosteroid (CS) medication. It has been demonstrated that CS give rise to cerebral atrophy[2]. It is unknown whether CS also influence changes in the brain detectable by MTI. The aim of this study was to assess the influence of CS on magnetization transfer ratio (MTR) histogram parameters in a group of subjects without central nervous system (CNS) disease.

Materials and methods

Twenty-seven patients suffering from rheumatoid arthritis (RA) and 15 healthy controls (Controls) were included in the study after written informed consent. None of the subjects had a history of neurologic or psychiatric disease. At the time of scanning, all RA patients were on regular RA treatment. CS had not been used for at least 25 years in 14 RA patients (RA CS-), while 13 RA patients were on current CS use (RA CS+). Both daily CS dosage at the time of scanning and lifetime cumulative CS dosage are listed in table 1.

MRI was carried out on a Philips Gyroscan Intera ACS-NT 1.5T MR scanner (Philips Medical Systems, Best, The Netherlands). Conventional MRI included T1-weighted, T2-weighted, proton density (Pd-) weighted and inversion-recovery images. All conventional images were interpreted by an experienced neuroradiologist. For MTI, a 3D gradient-echo pulse sequence with a TE/TR of 6/106 ms and a flip angle of 12º was used[3]. Scan parameters were chosen to minimize T1 and T2 weighting, resulting in Pd contrast in the absence of MT saturation pulses. A FOV of 220mm, matrix of 256x256, 50% acquisition percentage and scan time of 11:27 minutes were used for 28 contiguous 5mm slices. Two sets of axial images were acquired, with (Ms) and without (Mo) a sinc-shaped MT saturation pulse 1100 Hz upfield of H_2O resonance.

After co-registration of Mo and Ms images on an offline workstation, the magnetization transfer ratio (MTR) was calculated for every voxel with the equation Mo-Ms/Mo[1] (SNIPER®, Software for Neuro-Image Processing in Experimental Research, Division of Image Processing, Department of Radiology). Conventional MR images were co-registered to the Ms image to mask out white matter lesions in MTR maps.The intracranial and parenchymal compartment (>20pu) were segmented automatically and manually edited when necessary. White matter lesions were identified on conventional scans as marked on hardcopies. MTR histograms were generated from the whole- and normal-appearing brain tissue. From these MTR histograms, the peak height (corrected for volumes) and mean MTR were calculated[1].

Results

One-way Anova testing revealed a significant age difference between the Controls and RA CS+ patients (p=0.025 with Bonferroni correction), however no significant difference was found for disease duration between RA CS- and RA CS+ patients (p=0.186). Because of the significant age difference between Controls and RA CS+ patients, MTR histogram parameters for the whole brain tissue and normal-appearing brain tissue were statistically compared between the three groups of subjects using univariate analyses with age as a covariate. None of the univariate analyses revealed a significant difference in MTR histogram parameters between Controls, RA CS- and RA CS+ patients, while all of the parameters were significantly associated with age. Within the RA CS+ group, no correlation was found between cumulative CS dosage and any of the MTR histogram parameters (Pearson correlation all p>0.25). MTR histogram parameter values and univariate significance values were almost identical for the whole brain tissue and the normal-appearing brain tissue; this is due to the fact that lesion volumes were very small (0.06%, 0.15% and 0.3% of whole brain tissue volumes for Controls, RA CS- and RA CS+ patients respectively).

Conclusion

This is the first study to evaluate the effect of CS on MTI measurements. We have found no effect of CS on MTR histogram parameters in a group of subjects without CNS involvement. Furthermore, we have found age as a significant factor for all MTR histogram parameters, which is in accordance to literature[4]. These results demonstrate that in patients with cerebral disorders that are on CS medication, like NPSLE patients, the abnormalities detected by volumetric MTI analysis[5-6] can be attributed to the underlying disease and are not confounded by CS effects.

Table 1		Controls	RA CS-	RA CS+	p (group)	p (age)
Number of subjects		15	14	13	-----	-----
Age (years, ± sd)		45 ± 10	49 ± 13	58 ± 16	0.026 *	-----
Disease duration (years, ± sd)		-----	11 ± 10	6 ± 7	0.186	-----
CS at MRI (daily, milligram)		-----	-----	9.2 ± 2.8	-----	-----
CS lifetime (gram)		-----	-----	4.4 ± 4.9	-----	-----
Whole brain tissue volume (10^3 voxels)		307 ± 11	309 ± 27	295 ± 22	0.463	0.104
White matter lesion volume (voxels)		181 ± 516	485 ± 1333	977 ± 1201	0.748	0.005 *
Whole brain tissue	Mean MTR (percent unit)	34.1± 0.5	33.8 ± 0.4	33.5 ± 0.6	0.147	0.000 *
Whole brain tissue	MTR peak height (10^{-3}, arbitrary unit)	121 ± 7.8	114 ± 10	112 ± 8.9	0.152	0.001 *
Normal-appearing brain tissue	Mean MTR (percent unit)	34.1± 0.5	33.8 ± 0.4	33.5 ± 0.6	0.148	0.000 *
Normal-appearing brain tissue	MTR peak height (10^{-3}, arbitrary unit)	121 ± 7.7	114 ± 10	112 ± 8.9	0.152	0.001 *

References

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