BRAIN MRI CORRELATES OF MAGNETIZATION TRANSFER IMAGING METRICS IN PATIENTS WITH MULTIPLE SCLEROSIS

M. Rovaris, M. Bozzali, M. Rodegher, C. Tortorella, G. Comi, M. Filippi

Neuroimaging Research Unit, Dept. of Neuroscience, H San Raffaele, Milan, Italy

Introduction

The pathological specifity of magnetization transfer imaging (MTI) measures makes them promising magnetic resonance imaging (MRI) markers of disease severity in multiple sclerosis (MS) (1, 2). Several studies (3-5) found that MT ratio (MTR) histogram measures well distinguish MS patients from healthy controls and that MTR histogram-derived measures are strongly correlated with clinical disability (5) and cognitive impairment (4). Other studies (3, 6) suggested that MTR histogram parameters in MS patients are influenced by the volume of brain parenchyma and the disease burden. However, the relative influence of burden and severity of macroscopic MS lesions and degree of brain atrophy on various MTR histogram parameters (i.e., average brain MTR, histogram peak position and height) has not yet been fully elucidated. Aim of the present study was to investigate which MRI measure best predicts the values of MTR histogram parameters in MS patients.

Patients and methods.

Patients with relapsing-remitting (RR) or secondary progressive (SP) MS were included into the study. Brain MRI scans were performed using a 1.5 Tesla machine (Siemens Magnetom SP 63). Dual-echo (TR = 2400, TE = 30/80) conventional spin echo (CSE), unenhanced T1-weighted CSE (TR = 500, TE = 15) and MTI (TR = 600, TE = 12, flip angle = 20°, obtained with and without a saturation pulse) scans were obtained. Twenty-four (20 for MTI) axial contiguous interleaved 5-mm thick slices with image matrix = 256 x 256 and field of view = 25 cm were acquired. Total lesion loads (LL) were assessed from T2- and T1-weighted images using a semiautomated segmentation technique (7). A measure of brain atrophy was derived from T1-weighted images by computing the volume of brain tissue segmented from a slab of 5 consecutive slices rostral to the velum interpositum (8). From MTI scans, MTR maps were calculated and MTR histogram analysis (4) was performed for the whole brain. For each histogram, several parameters were analysed: the average MTR value, the height and the location of the histogram peak with respect to the x axis. Average lesion MTR was also calculated. Univariate correlations between MTI metrics and other MRI measures were performed using the Spearman Rank Correlation Coefficient (SRCC). To assess the MRI measure that best predicted the values of MTR histogram parameters, multivariate logistic regression was used.

Results.

We studied 42 patients, 25 with RR and 17 with SP MS. Their mean age was 34.1 years (range 21-53 years), mean disease duration was 7.6 years (range 3-24 years) and median expanded disability status scale (EDSS) score was 4.0 (range 1.0-6.5). Table 1 reports the means, medians and ranges for each MRI measure we considered. Brain volume was significantly correlated with both T2-weighted (r=-0.54, p<0.0001) and T1-weighted (r=-0.46, p=0.002) LL. Table 2 reports the "r" values for the correlations between MTI metrics and other MRI measures. Significant correlations were found between : a) T2-weighted LL and brain tissue MTR and histogram peak height; b) T1-weighted LL and lesion MTR and brain tissue MTR; c) T1/T2 LL ratio and lesion MTR. Brain volume was significantly correlated with all the MTI measures except lesion MTR and

histogram peak location. The multivariate analysis showed that brain volume alone significantly predicted the values of average brain MTR (p=0.0002), histogram relative peak height (p=0.003) and location (p=0.0002). The ratio between hypointense T1-weighted and hyperintense T2-weighted LL significantly predicted the values of average lesion MTR (p<0.05).

Table 1. Brain MRI and MTR histogram findings.

	Mean	Median	Range
T2-weighted LL (ml)	27.5	20.2	0.8-100.7
T1-weighted LL (ml)	4.9	2.2	0.2-22.3
T1 / T2 LL ratio (%)	16	13	1-49
Cerebral volume (ml)	353.4	357.2	277.7-428.3
Lesion MTR (%)	37.5	37.6	29.9-44.7
Brain MTR (%)	43.1	43.3	37.7-46.0
Histogram peak height	56.9	57.0	43.4-70.6
Histogram peak location	42.7	43.0	35.0-46.0

Table 2. Correlations of MTI-derived metrics with other MRI measures (significant SRCC are in bold).

	T2W LL	T1W LL	T1/T2 LL ratio	Cerebral volume
Lesion MTR	0.02	**-0.30** (p=0.05)	**-0.44** (p=0.003)	0.17
Brain MTR	**-0.38** (p<0.02)	**-0.34** (p<0.03)	-0.05	**0.57** (p<0.001)
Histogram peak height	**-0.39** (p<0.01)	-0.27	0.09	**0.46** (p=0.002)
Histogram peak location	-0.10	-0.18	-0.21	0.19

Conclusions.

The robust correlations of T2- and T1-weighted lesion loads with MTI-derived metrics confirm that MTI can be used in MS as a reliable method to assess the overall disease burden and severity. The significant influence of brain atrophy on MTR histogram parameters supports the hypothesis that MTR histogram analysis in MS patients may provide, at the same time, information about the pathological process (either macro- or microscopic) and about its impact on the loss of brain parenchyma.

References

1. Grossman, R.I. Ann Neurol 36, S97, 1994.
2. McGowan, J.C., Filippi, M., Campi, A., Grossman, R.I. JNNP 64 (Suppl 1), S66, 1998.
3. van Buchem, M.A., McGowan, J.C., Kolson, D.L. et al. Magn Reson Med 36, 632, 1996.
4. Rovaris, M., Filippi, M., Falautano, M. et al. Neurology, 50, 1601, 1998.
5. van Buchem, M.A., Grossman, R.I., Armstrong, C. et al. Neurology, 50, 1609, 1998.
6. Phillips, M.D., Grossman, R.I., Miki, Y. et al. AJNR 19, 1055, 1998.
7. Rovaris, M., Filippi, M., Calori, G. et al. J Neurol 244, 266, 1997.
8. Losseff, N.A., Wang, L., Lai, H.M. et al. Brain 119, 2009, 1996.