

T₂^{*}-weighted images discriminate multiple sclerosis from ischaemic lesions

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INTRODUCTION MRI is invaluable in assisting the diagnosis of Multiple Sclerosis (MS) as it demonstrates white matter (WM) lesions in the brain and spinal cord. However, it can be difficult to differentiate between MS lesions and small ischaemic brain lesions caused by smoking, hypertension and increased age. Although the use of MRI has reduced the number of incorrect diagnoses, and many sets of criteria for distinguishing between these types of lesions have been devised^{1,2}, none of these are pathognomonic, and misdiagnosis is still common.

Histological studies of MS have shown that most MS brain lesions are centred on small parenchymal veins. The close spatial relationship between lesions and veins is in line with the hypothesis that MS lesions are formed when inflammatory cells enter the brain from the bloodstream. The perivenous orientation of lesions could therefore act as an imaging marker of MS lesions. However, in vivo demonstration of perivenous lesions is difficult because of difficulties visualising both blood vessels and lesions in the same image. T₂-weighted MRI has previously been compared with subsequent venography to investigate the relationship between lesions and veins³. However, this method relies heavily on the ability to coregister accurately the two sets of images, and the size of veins detectable with this method (time-of-flight MRA) is relatively large; the accurate characterisation of the spatial relationship between the veins and lesions is therefore challenging.

Recently we have shown that T₂^{*}-weighted MRI at 7 T can be used to demonstrate both lesions and parenchymal veins in the same image. We identified veins in 82% of WM MS lesions, in keeping with the histological studies⁴. In this work, we use T₂^{*}-weighted MRI at 7 T to compare WM lesions in patients with MS and those with asymptomatic cerebral ischaemia, and show that perivenous lesion orientation is predictive of presence of MS.

METHODS 27 patients with MS [15 male, 12 female; mean age 46.4 y, range 24-65] and 17 subjects with ischaemic WM lesions [13 male, 4 female; mean age 60.8 y, range 34-77 y] were studied, with approval from the local research ethics committee. MR images were acquired using a Philips Achieva 7 T scanner, with whole-body gradients, 16-channel SENSE head-only receive coil (Nova Medical), and head-only volume transmit coil. A 3D gradient-echo sequence was used to acquire 200 transverse slices in 4 stacks, each overlapping by 10 slices [0.5-mm isotropic voxels; TE = 20ms; TR = 150 ms; flip angle 14°; parallel imaging SENSE factor 2 (RL); EPI factor 3; Acquisition time 8.8 minutes].

Images were viewed in orthogonal planes and WM lesions in all subjects were outlined by one observer, blinded to disease status. The lesion volume was calculated, and lesions were classified as periventricular (with a border ≤ one voxel from ventricular surface), subcortical (with border ≤ 1 voxel from cortex) or deep WM. The presence or absence of a central vein was noted. Veins were counted only if they could be visualised in at least 2 planes, appeared linear in one plane and were completely surrounded by hyperintense signal in at least one plane.

RESULTS 901 WM lesions were detected in the brains of the MS patients [range 4 – 83 lesions per patient; mean 33 lesions; mean lesion volume 0.095 ml] and 428 in the brains of subjects with asymptomatic ischaemia [range 1 – 76 per subject, mean 25; mean volume 0.094 ml]. Examples are shown in Fig 1. WM lesions in patients with MS were significantly more likely to have perivenous orientation than those in patients with ischaemia (80% versus 19%; p < 0.001). The proportion of perivenous lesions in individual MS patients (mean 80%, range 53 – 100%) was consistently much higher than in individual ischaemic patients (mean 16%, range 0 – 34%).

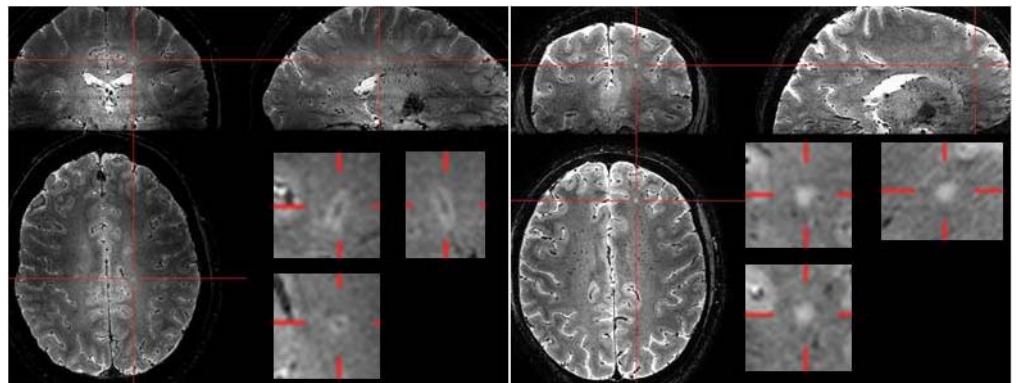


Figure 1 – Example of WM lesion shown in 3 planes for patient with MS (left) and ischaemia (right). A magnified region centred on the lesion is also shown.

DISCUSSION & CONCLUSIONS These results suggest that T₂^{*}-weighted MRI at 7 T can be used to differentiate between patients with MS and ischaemia. Further work to increase the sensitivity to small veins may improve this technique and enable its translation to lower-field scanners. Provided the results reported here are substantiated in larger trials, this would enable the widespread use of this technique for differential diagnosis of MS.

REFERENCES 1. Fazekas et al, Neurology 1988; 38:1822-5. 2. Polman et al, Ann Neurol 2005; 58: 840. 3. Kozinska et al, NeuroImage 2004; 22: 1671-8. 4. Tallantyre et al, Neurology 2008; 39: 1682-92.

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