Presentations of Multiple Sclerosis lesions on quantitative susceptibility mapping (QSM)

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Purpose:

Although T2FLAIR is highly sensitive for detecting lesions in multiple sclerosis (MS) patients, it is difficult to differentiate different types of MS lesions on T2FLAIR. Contrast-enhanced T1 weighted imaging (CET1W) has the capability of distinguishing active MS lesions from inactive ones [1,2]. Previous studies have shown that iron deposition is associated with demyelination [3,4]. Quantitative susceptibility mapping (QSM) is an imaging technique that is sensitive to iron deposition [5]. Here, we explore whether QSM can contribute to the discrimination of the different types of MS lesions.

Materials&methods:

A radiologist retrospectively reviewed T2FLAIR, QSM (display level=0), and CET1W of 19 patients (ages 34-48; 4M/15F) examined at a 3T MR scanner with clinically confirmed MS. Lesions were identified on these three sequences. Signal intensities of MS lesions were assessed.

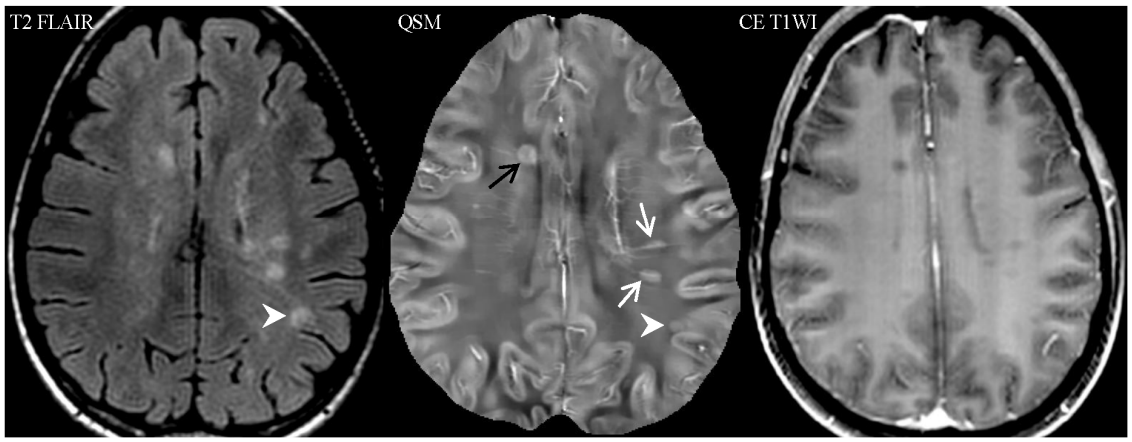

Fig.1 shows the MS lesions of type 1 (white arrows), type 3 (arrowheads), and type 5 (black arrow)

Results:

A total of 203 MS lesions were detected on T2FLAIR, 151 (74.4%) of which presented on QSM. Four lesions (2.0%) showed enhancement on CET1W. Table 1 summarized eight types of MS lesions categorized by combining T2FLAIR, QSM, and CET1W. The QSM patterns for the top four types of observed MS lesions (T2FLAIR hyperintense CET1W nonenhanced) were: 1) positive with associated veins only (35.5%), 2) not present (25.6%), 3) positive without associated veins or a surrounding positive ring (20.7%), and 4) positive with both associated veins and a surrounding positive ring (8.4%). An exemplary case is shown in Fig. 1, where typical venocentric lesions [6,7] were appreciated on QSM, but the medullary veins could not be seen on T2FLAIR or CE T1W.

Type	Number	T2FLAIR	QSM	CE T1W
1	72 (35.5%)	hyperintense	positive lesion with associated veins only	nonenhanced
2	52 (25.6%)	hyperintense	not present	nonenhanced
3	42 (20.7%)	hyperintense	positive lesion without associated veins or a surrounding positive ring	nonenhanced
4	17 (8.4%)	hyperintense	positive lesion with both associated veins and a surrounding positive ring	nonenhanced
5	8 (3.9%)	hyperintense	positive lesion with a surrounding positive ring only	nonenhanced
6	8 (3.9%)	hyperintense	concentric positive lesion with associated veins	nonenhanced
7	3 (1.5%)	hyperintense	positive lesion without associated veins or a surrounding positive ring	enhanced
8	1 (0.5%)	hyperintense	positive lesion with associated veins and a surrounding positive ring	enhanced

Table 1: MS lesions were categorized into 8 types by combination of T2-FLAIR, QSM, and CE T1W

Discussion and Conclusions:

Combination of T2FLAIR, CET1W and QSM images demonstrates eight distinct patterns of MS lesions in our MS data. The paramagnetic ring around the MS lesions may suggest iron-rich macrophages around the MS lesions. 25.6% of MS lesions are not present on QSM, probably because these lesions were edemas that do not contain iron. The clinical meanings of the 8 types of MS lesions observed in T2FLAIR+CET1W+QSM according to their voxel value and geometry may be understood through further investigation by correlating with pathology and neurology evaluations.

Reference: [1] Al-Saeed et al. Acta Radiol: 52(5):570-4; [2] Uysal et al. AJR: 188(3):697-702; [3] Williams et al. BMC Neurosci:12:59; [4] Filippi et al. Radiology: 259(3):659-81; [5] Liu et al. MRM: 66(3):777-83; [6] Zamboni et al. Curr Neurovasc Res: 4(4):252-8; [7] Hammond et al. Ann Neurol: 64(6):707-13.