

Magnetisation transfer contrast of bone marrow oedema in arthritis

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Introduction:

Bone marrow oedema seen on MRI is an important finding in rheumatoid arthritis (RA) and osteoarthritis (OA). For example, in rheumatoid arthritis it is the best MRI predictor of erosive outcome. Conventional assessment is with T2W fat suppressed images supplemented by T1W images. Quantification is based on the extent of the oedema.

Magnetisation transfer contrast (MTC) is widely used, for example in the brain, where it has been found to improve contrast. Furthermore, quantitative measurement of the magnetisation transfer ratio (MTR), related to interactions between free water and bound macromolecular proteins, have been found to be robust and valuable.

The aim of this work was to investigate the use of MTC in bone marrow oedema in arthritis to determine if oedematous bone shows greater magnetisation transfer than normal bone, if MTC can improve contrast between oedematous and normal bone and if measurement of the MTR may be feasible in arthritis.

Method:

18 patients with a diagnosis of arthritis and foot symptoms were studied (8 OA, 10 RA).

Imaging was performed at 3T using an 8 channel foot and ankle or knee coil. Sagittal T1W (TR=700ms, TE=10ms), STIR (TR=4500ms, TE=31ms, TI=200ms) and T2 fat sat (TR=3500ms, TE=69) images were acquired. Sagittal SPGR (TR=450ms, TE=2.46ms, flip-angle=30°) images were acquired with and without MTC.

Bone marrow oedema was identified from T2W fat suppressed images by a consultant musculoskeletal radiologist with experience of assessing oedema in arthritis. Regions of interest ~5 mm in diameter were placed over (i) oedematous bone and (ii) adjacent non-oedematous bone, blinded to the MTC images. Care was taken not to include cysts or erosions.

Signal intensity measurements from the same ROIs in the SPGR images with and without MTC were used to calculate: (i) the magnetisation transfer ratio $(M_0 - M_{mt})/M_0$; (ii) the magnetisation transfer difference, $M_0 - M_{mt}$ and (iii) contrast between oedematous and non-oedematous bone.

MTR and magnetisation transfer differences were compared between normal and oedematous bone. Contrast between oedematous and adjacent non-oedematous bone was compared between images with MTC and without MTC.

Results:

MTR was significantly higher in oedematous bone when compared to non oedematous bone ($p = 0.004$). This was true for both groups of patients (OA: $p = 0.006$ and RA: $p = 0.002$). MT difference was also significantly higher in oedematous bone ($p = 0.007$). The contrast of oedematous bone was significantly greater on the SPGR images with MT than without MT ($p = 0.008$).

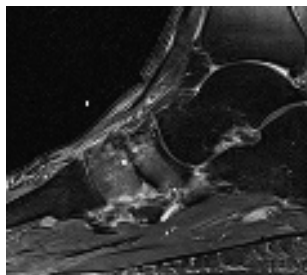


Fig1: Sagittal T2 FS

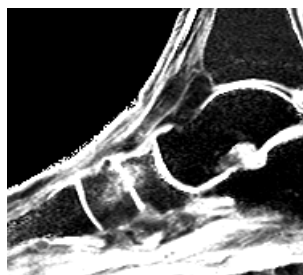


Fig 2: Sagittal MTR image

Discussion:

These results suggest that oedematous bone marrow exhibits greater magnetisation transfer than normal marrow. This is in keeping with recent histological studies which show that oedematous bone has increased cellularity and fibrosis as well as increased fluid content [1]. MT imaging may provide additional information about these components not available from conventional T1 and T2 weighted imaging.

MTC may be used to improve contrast between normal and oedematous bone on T1 weighted images. Although T2-weighted fat suppressed images remain the gold standard for assessing oedema, T1 images may be valuable, for example if fat suppression is suboptimal.

The MTR differs between normal and oedematous bone. MTR from T1 weighted images is likely to be a good measure because it combines the effects of increased MT and T1 in bone marrow oedema. It may therefore provide a simple, robust method for quantifying bone marrow oedema based on signal intensities.

In conclusion, this study shows magnetisation transfer is feasible and may be a useful source of contrast in the assessment of bone marrow oedema in arthritis.

References:

[1] McQueen FM et al. A vital clue to deciphering bone pathology: MRI bone oedema in rheumatoid arthritis and osteoarthritis. *Ann Rheum Dis.* 2007 Dec;66(12):1581-7.