

Interrogation of short T2 components in sclerotic bone metastases with Ultra Short TE MRI

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Introduction Ultra short TE (UTE) MR employs half RF excitations followed by radial filling of k space to reduce TEs to a μ s range. This allows detection of signal from very short T2 tissue that previously returned no signal on conventional MR sequences¹. Our aim was to investigate the feasibility of UTE imaging of short T2 components in sclerotic bone metastases.

Methods Sagittal UTE lumbar spine was performed in 4 healthy volunteers and 7 patients with known sclerotic metastatic bone disease on a Siemens Avanto 1.5T; (TR 500ms; TEs 0.07, 4.7, 9.4ms; FOV 400cm, matrix 512, 2 averages; flip angle 85°; BW 540Hz, fat saturation; 4mm slice thickness). Image optimisation: Signal acquisition was maximised by adding a body coil over the area of interest. Inaccurately spatially encoded information which occurs due to non-linearity of gradients was minimised by switching off coil elements at the extremity of the FOV. The number of radial lines was 960 and FOV was 800mm, which moves artefacts away from the region of interest. The increased number of k-space lines increases time for image acquisition over the scan with artefact. Further measures to decrease artefacts were achieved by selecting the TIM “triple mode” which is often found to be beneficial with radial scanning. Total imaging time 8 minutes. Signal as a function of TE was investigated.

Results Radial artifact was reduced in optimised images (Fig 1) which enabled clearer visualization of metastases than on T1-W images (Fig 2). In these lesions signal change was greatest at TE<4.7ms. The UTE sequence also showed definite increase in signal in lesions responding to treatment (as evidenced by serum biomarkers) when no observable response was detectable on standard MR (Fig 4).

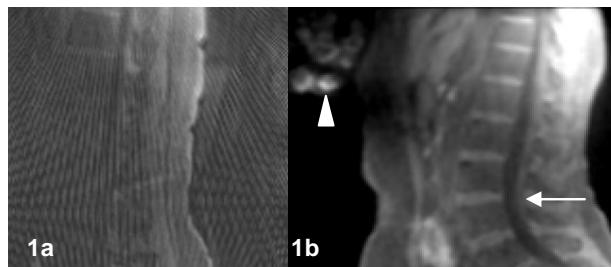


Fig 1a: Sagittal UTE imaging lumbar spine of a healthy volunteer, TE 0.07ms. The image is severely degraded by radial artefacts owing to the turnover of the gradient field that combines with the undersampled radial k space coverage. **Fig 1b:** optimised UTE lumbar spine of a healthy volunteer. High signal is seen in short T2 components such as intervertebral discs (arrow) and in the carpal bones of the hand resting on the volunteer's abdomen (arrowhead).

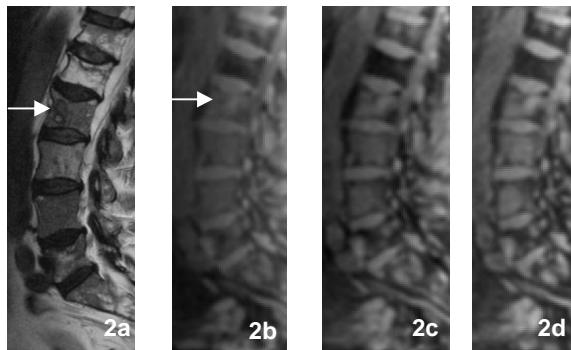


Fig 2. Sagittal lumbar spine T1W MR (a) and UTE imaging at TE 0.07 (b), 4.7 (c), 9.4ms (d) of a patient with sclerotic bone metastases from carcinoma of the prostate. Little signal is seen in the metastases on the T1W image. On UTE MR the metastases return high signal (arrows).

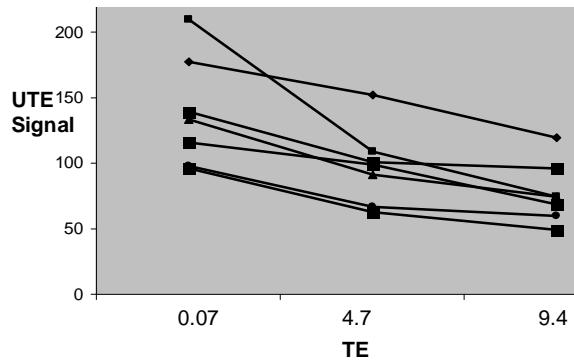


Fig 3. UTE signal vs TE curves of sclerotic metastases (n=7) showing greatest signal change between TE 0.07 and 4.7ms.

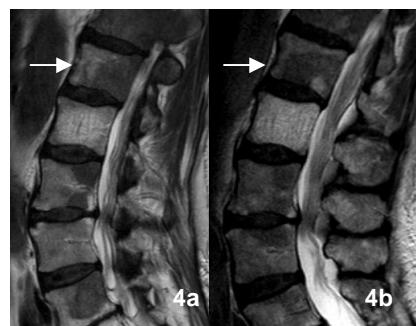


Fig 4. Sagittal T2W lumbar spine of a patient with bone metastases from carcinoma of the prostate before (a) and after treatment (b) shows little change. Sagittal UTE MRI (TE 0.07ms) of the same patient before (c) and after treatment (d) demonstrates an increase in short T2 tissues within the metastasis in L1 (arrows). This is confirmed by corresponding pre and post treatment CTs which showed increased sclerosis. Increased sclerosis is likely to be a feature of a healing response as the serum prostate specific antigen fell from 82 to 14.1ng/ml.

Discussion and Conclusion

We have optimised UTE MRI of the spine to return signal from short T2 components in sclerotic bone metastases. Careful coil selection and large FOV and matrix size can overcome artefacts from non-linearity of gradients although this can result in a time penalty. UTE has potential for quantitative assessment of sclerotic bone metastases but further measurements between 0.07 and 4.7ms are necessary to optimise TEs and remove effects of long T2 components. An alternative fat saturation technique should also be investigated to minimise the potential for saturation of broad band width short T2 tissues.

References: 1. Robson MD, Bydder GM. NMR Biomed 2006; 19(7): 765-80.

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