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LETTER TO THE EDITOR

Synthetic MRI of the knee: new perspectives in musculoskeletal imaging and possible applications for the assessment of bone marrow disorders

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(The Editors do not hold themselves responsible for opinions expressed by correspondents)

To the Editor,

It was with great interest that we read the paper by Park et al¹ titled “Initial experience with synthetic MRI of the knee at 3T: comparison with conventional T_1 weighted imaging and T_2 mapping” published recently in the British Journal of Radiology.¹

Since its development in 2007 by Warntjes et al² in Linköping, Sweden, the clinical accuracy of synthetic MRI in detecting various neuropathological disorders, such as multiple sclerosis,³ brain metastases,⁴ Sturge-Weber syndrome⁵ and meningitis,⁶ has been proven. In the study by Park et al, the authors assessed the accuracy of synthetic MRI for obtaining T_1 weighted (T1W) images and performing quantitative T_2 mapping of the knee at 3T, while achieving a shorter scanning time than that required for conventional T1W and multiecho spin-echo (MESE) sequences. To our knowledge, the study by Park et al was the first to evaluate the feasibility of applying synthetic MRI to the musculoskeletal system, thus opening new avenues for applications in this field.

The study showed that the T_2 values obtained for cartilage and muscle using synthetic MRI and the MESE sequences were comparable, whereas the T_2 values obtained for bone marrow were significantly higher when MESE sequences were used. Additionally, unlike for cartilage and muscle, the relative signal intensity of bone marrow was higher when synthetic MRI sequences were used, whereas the relative contrast of bone marrow to muscle was higher when conventional T1W sequences were used. The authors rightly explained that these differences arise owing to the limited number of relaxation data points in synthetic MRI,

which makes it less reliable for examining tissues with very short or very long T_2 times, such as bone marrow. Optimization of synthetic MRI sequences for musculoskeletal imaging will be necessary for improving accuracy during bone marrow examination. Even though the T_2 values obtained using both techniques were significantly different in this preliminary study, the baseline values can still be used for the follow-up of pathological conditions such as osteoarthritis or tumour infiltration.

We must also consider that bone marrow is a complex tissue composed of a variable mixture of fatty components and haematopoietic cells embedded in the bone mineral matrix. The varying contributions from water and lipid protons result in multiexponential decay. Synthetic MRI assumes a mono-exponential decay model where the measured relaxation rates reflect the dominant component of the relaxation behaviour.² Speculations exist on the degree to which the coexistence of water and lipid protons in the same voxel affect the T_2 relaxation variations, especially in bone marrow disorders.

Fat saturation techniques allow the extraction of the water signal by neutralizing the fat signal, resulting in a signal that may fit the mono-exponential decay curve. In order to evaluate the effect of fat saturation on T_2 measurements using synthetic MRI, we scanned the pelvis of a volunteer on a 3T scanner (Ingenia, Philips Healthcare, Best, Netherlands) with and without fat saturation. Despite the presence of areas of inhomogeneity owing to a spectral pre-saturation with inversion recovery pulse, T_2 mapping revealed an overall decrease in T_2 values in the bone marrow. For example, T_2 values at the femoral neck were about 55 ms on fat-suppressed images but 83 ms when fat saturation was not applied (Figure 1).

Figure 1. T_2 maps of the proximal femur obtained using synthetic MRI from turbo spin-echo sequences without (a) and with (b) fat saturation. Regions-of-interest are overlaid on these maps.

A complementary evaluation of T_1 mapping in bone marrow by synthetic MRI would have also been relevant. Indeed, T1W images are highly sensitive to tumour infiltration of the bone marrow, which causes a lengthening of T_1 relaxation, and consequently, signal loss.⁷ Smith et al⁸ assessed the effectiveness of T_1 mapping using conventional sequences in the evaluation of lumbar vertebral bone marrow in patients with Hodgkin's disease before and after intensive chemotherapy. The authors provided ranges of normal and pathological T_1 values, which could be used as a reference database for future evaluations.

Further studies are needed to explore the feasibility of synthetic MRI for performing T_1 and T_2 mapping for the assessment

and monitoring of bone marrow lesions after treatment in cases of metastatic cancer and malignant haematological disorders.

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