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(G*) Magnetic Particle Imaging can be used for in vivo assessment of the breast tumour microenvironment

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Tumour associated macrophages (TAMs) constitute up to 50% of the breast cancer microenvironment and are linked to adverse patient outcomes. Conventionally, TAM density is assessed through immunohistochemistry (IHC); however, this relies on invasive biopsies and is not representative of the entire tumour. Thus, there is a need for non-invasive, quantitative imaging for in vivo TAM assessment. Superparamagnetic iron oxide (SPIO) particles have been injected intravenously (IV) to label macrophages in situ for TAM imaging with MRI; however, quantifying TAM density is challenging. Magnetic particle imaging (MPI) is an emerging modality which can detect cells labelled with SPIO nanoparticles and can be used for non-invasive TAM assessment.

MPI has previously been evaluated for TAM cell tracking, however, quantification was only possible for fixed tumour tissues imaged ex vivo due to known dynamic range limitations. When iron samples with large differences in concentrations are present in the same field of view (FOV) there is signal oversaturation from the higher signal due to the requirement for regularization for stable reconstruction. This represents a major roadblock for in vivo MPI in applications where two or more sources of signal exist. In this study, we address this challenge by employing an advanced reconstruction algorithm, allowing for a small FOV to be focused on the tumour. We then demonstrate the success of this method with an in vivo tumour model and show enhanced image quality and successful quantification of TAMs in mouse mammary tumours with different metastatic potentials (4T1, n=8 and E0771, n=8).

Utilizing in vivo MPI, we did not see significant differences in the MPI signal for 4T1 tumours compared to E0771. This work presents the first demonstration of in vivo imaging and quantification of TAMs using MPI. Our findings highlight the potential of MPI for in vivo TAM quantification despite dynamic range limitations, offering a promising avenue for broader applications in cancer research and potentially overcoming constraints of MPI in other in vivo imaging contexts.

Keyword-1

Breast Cancer

Keyword-2

Magnetic Particle Imaging

Keyword-3

Cell Tracking

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