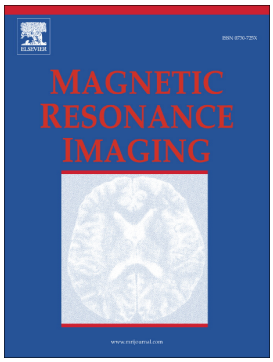

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A new discrete dipole kernel for quantitative susceptibility mapping

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Abstract: Purpose: Most approaches for quantitative susceptibility mapping (QSM) are based on a forward model approximation that employs a continuous Fourier transform operator to solve a differential equation system. Such formulation, however, is prone to high-frequency aliasing. The aim of this study was to reduce such errors using an alternative dipole kernel formulation based on the discrete Fourier transform and discrete operators. Methods: The impact of such an approach on forward model calculation and susceptibility inversion was evaluated in contrast to the continuous formulation both with synthetic phantoms and in vivo MRI data.

Results: The discrete kernel demonstrated systematically better fits to analytic field solutions, and showed less over-oscillations and aliasing artifacts while preserving low- and medium-frequency responses relative to those obtained with the continuous kernel. In the context of QSM estimation, the use of the proposed discrete kernel resulted in error reduction and increased sharpness. Conclusion: This proof-of-concept study demonstrated that discretizing the dipole kernel is advantageous for QSM. The impact on small or narrow structures such as the venous vasculature might by particularly relevant